THEORY OF ORGANIC BEINGS

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JĘDRZEJ ŚNIADECKI

VILNIUS 2018

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Compiled by: Birutė Railienė, Rimvydas Baranauskas
Translated from Polish by Krzysztof Mazurek
Scientific editor Jan Surman
Subject editors: Rimantas Vaitkus, Gervydas Dienys
Scientific advisor Jan Golinski
Scientific notes by: Krzysztof Mazurek, Jan Surman
Index of names by: Krzysztof Mazurek, Marina Ivinskaja
Index of place names by: Irena Katilienė, Marina Ivinskaja
Design and style Miglė Datkūnaitė

COMMEMORATING
250th BIRTH ANNIVERSARY
OF
JĘDRZEJ ŚNIADECKI

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Preface to English translation

Professor Jędrzej Śniadecki (1768–1838), who's 250th birth anniversary is celebrated this year, was certainly one of the very first scientists in the world to speak about the chemistry of life and life sciences in terms of both scientific research and philosophical debate. Ahead of his time, he could have possibly witnessed the very birth of modern biochemistry and stood at the cradle of the contemporary biotechnology.

After his medical and chemical studies in the leading universities of Europe at the time, he arrived to teach chemistry at the Vilnius University in 1797 and continued working there until the last day of his life. As early as eighteen hundreds, at the time of his most productive years, when Sniadecki lived in Vilnius and worked at the Vilnius University, probably, no single individual can claim the right to be called a grandfather of modern biochemistry, as we know it today. Nevertheless, he opened new horizons in organic and life chemistry and persistently transferred his knowledge and ideas to his students and disciples. Sniadecki created or greatly contributed to a scientific school of chemistry, chemical technology, biochemistry, pharmacy, physiology, medicine and pediatrics' as well as founded, facilitated and chaired a number of publications and scientific or special interest societies.

As a sequence of failed uprising, attempting to restore Lithuanian state and regain the independence from the Russian empire in 1831, Vilnius University was closed down by the Russian tsar in 1832. The academic life and scientific research in Vilnius has been abruptly stopped and has not been restarted for almost a century. World renowned disciples of Śniadecki, like Ignacio Domeyko Ancuta and Ignacy Fonberg, left Vilnius in search for the possibility to continue working in their field and make a decent living elsewhere in Europe and even Chile, spreading the knowledge gained from lectures of and work with Śniadecki. Very early in the lifecycle of the newly born modern sciences, Vilnius University lost a historical chance to develop into the competence centre of European importance in the field of biology, chemistry and life sciences in general.

Almost entire of his long and productive professional life as a scientist and a teacher at Vilnius university (Professor and Chair of the Chemistry department), Sniadecki has worked on his *magnum opus*, the *Theory of Organic Beings*, starting as early as his study years at the Universities of Pavia and Edinburg in 1793–1797 and working all the way through his successful career as a scientist and professor at Vilnius University. Almost immediately after the first edition in Polish of volume I in 1804 and volume II in 1811, which was very unusual language for the scientific publication at the time, this book was translated to German and French in 1810/1821 and 1825 respectively. Fortunately, Śniadecki managed to complete the final editing of the second edition of the *Theory of Organic Beings* in person and submit it to the printing house just before his death in 1838.

At the end of the year 1838 the book left the printing press as a complete and revised second edition, which came out in three volumes in Polish.

Since 2012, every single year a special seminar, under the name of "Lectiones Andreae Śniadecki", has been held in honor of Śniadecki in Vilnius. More information on Śniadecki as well as activities related to his heritage can be found in the dedicated website at www.andrewsniadecki.org . A group of enthusiasts, consisting of people with various backgrounds and occupations but united in their love and interest in the scientific history of Vilnius University and Jędrzej Śniadecki in person, have joined their efforts in order to make the *Theory of Organic Beings* more accessible to the contemporary academic community. For several years it has been our intention to translate this work to English and to introduce ideas and teachings of Sciadecki to the English speaking historians of chemistry and life science around the globe.

The volume in your hands is English translation of the comprehensive second edition of the *Theory of Organic Beings* published in 1838, which, for the first time, we can read and enjoy in English already. We trust that this publication will draw the attention of international scholars in the field and encourage some new comprehensive research to be carried out of this truly trailblazing publication. We hope that due to this translation, Śniadecki will be rescued from the undeserved obscurity and ultimately acknowledged, appreciated and honored by the international academic community as a pioneer in life chemistry and much broader context of life sciences in the world.

The English edition includes all the texts of the original 1838 release, namely the prefaces to the first and second editions in the Polish language, 646 paragraphs of the text, a reprint of "Wiadomość o życiu i pismach Jędrzeja Śniadeckiego" ("News on Life and Works of Jędrzej Śniadecki") from the third volume, which was released in 1838 already after the author's death, and followed by the list of subscribers. This edition also contains article "Śniadecki's *Theory of Organic Beings* in the context of European science" by Professor Jan Golinski and "Translators notes" by Krzysztof Mazurek.

To the extent it was possible we have striven to adhere to both, the layout and design patterns of the publication of 1838 as well as exceptionally individual style of expression of Sniadecki. However, we must admit that some rather minor and insignificant changes were inevitable to make the publication more accessible and better understood by the contemporary reader. Author's notes in the 1838 edition had individual numbering in each volume. This has been changed to one uniform and continuous numbering throughout the entire publication. If deemed necessary, the notes were supplemented by bibliographical data in square brackets. The editor's and translator's comments and explanations are provided either at the bottom of the page (indexed in the letters of Latin alphabet) or are presented in the glossary, together with a short biographical information on philosophers and scientists mentioned in the text. Since Śniadecki himself introduced Latin terminology with a thorough explanation, it was decided not to repeat it in the glossary. At the end of the book there is an "Index of names and place names”, which also includes historical place names and some contemporary place names added by the publisher.

We have been heard, understood and supported by a company Thermo Fisher Scientific. Their support allowed carrying out the project in full scope and on time.

We are grateful for the information provided by the Wróblewski Library of the Lithuanian Academy of Sciences and the Vilnius University Library. Also, we would like to express our gratitude to everybody, who supported, advised and encouraged us along the way for the duration of almost two years. We would like to thank in person some members of our coherent team who helped to prepare and publish his book: Hasok Chang, Gervydas Dienys, Adam Gadomski, Egidijus Gotalskis, Vilma Gudienė, Emilija Ivaškevič, Vadimas Ivinskij, Egidijus Jaseliūnas, Irena Katilienė, Dobilas Kirvelis, Kamilė Kalibataitė, Juozapas Algimantas Krikštopaitis, Algimantas Markauskas, Giedrė Miknienė, Sigitas Narbutas, Laurynas Marcinkevičius, Saulius Špokevičius, Zbigniew Andrew Szydło, Teresė Rauckytė-Żak, Rimantas Vaitkus, Gytis Vaškelis, Włodzimierz Wypych, Andrzej Wróblewski.

BIRUTĖ RAILIENĖ AND
RIMVYDAS BARANAUSKAS

18

Śniadecki's *Theory of Organic Beings* in the context of European science

This volume presents an English translation of *Teorya jestestw organicznych* (*Theory of Organic Beings*) by the Polish-Lithuanian physician and chemist Jędrzej Śniadecki (1768–1838). The text was originally published in Polish in two volumes (1804 and 1811), with a third appearing after the author's death in 1838. It was partially translated into German (*Theorie der organischen Wesen*. Königsberg, 1810; Nürnberg, 1821) and French (*Théorie des êtres organisés*. Paris, 1825) during the author's lifetime, but has not previously appeared in English.

Śniadecki was born in the town of Żnin, then in the Polish-Lithuanian Commonwealth, and was the younger brother of Jan Śniadecki, who achieved distinction as a mathematician and astronomer. The younger Śniadecki chose to study medicine, initially at the Royal School in Kraków and then at the University of Pavia in Italy. There he studied with the clinician Johann Peter Frank, the anatomist and naturalist Lorenzo Spallanzani, and the physicist Alessandro Volta. Graduating with a medical degree in 1793, he traveled to London and then to Edinburgh, where he attended classes in chemistry and medicine. After spending a year at the University of Vienna — also renowned as a center of excellence in the medical sciences — he returned to his native land. In 1797, he was appointed Professor of Chemistry at the Academy and University of Vilnius, subsequently renamed the Imperial University of Vilnius by the government of the Russian Empire. Śniadecki assumed a central role in the institution, teaching in his native Polish, offering public lectures to audiences of men and women, and participating in the cultural organizations of the city.[1]

In his lectures and publications, Śniadecki introduced contemporary chemical and medical theory to his students and compatriots. Adopting Antoine Lavoisier's theory of combustion and respiration, he published the first edition of his comprehensive textbook of chemistry (*Początki chemii*) in 1800. The work is celebrated for having introduced modern chemical terminology into the Polish language, following the principles proposed by Lavoisier and his French colleagues whereby the names of compounds reflect their chemical composition. Śniadecki also organized the building of a new lecture hall and a laboratory equipped with up-to-date apparatus for teaching chemistry. Among the students who attended his lectures in Vilnius was the poet Adam Mickiewicz. Śniadecki also published on the law of chemical proportions in 1817, acknowledging the work of John Dalton, Humphry Davy, and Jöns Jacob Berzelius, and confirming their claim that elements are always

1 Zacharewicz, Witold. *Jędrzej Śniadecki*: *His Life and Scientific Work*. Warszawa: Państwowe Wydawnictwo Naukowe, 1975. 47 p.

present in compounds in integral multiples of specific quantities.[2] He retired from the chemistry chair in 1822, but returned after six years to a professorship in clinical therapeutics, which he held until his death.

Śniadecki's *Theory of Organic Beings* was an attempt to set out a comprehensive theory of living things, grounded in chemistry and aimed at improving medical treatment. It reflected an interest in the chemical processes of life that was widespread in the period. Although Śniadecki cited few sources in his first volume, he tipped his hat to Davy, whose bold experiments in breathing various gases had illuminated the chemistry of respiration. In the preface to the second edition, he also mentioned the English chemists William Allen and William Haseldine Pepys, whom he may have met in London. The legacy of Lavoisier's self-proclaimed "chemical revolution" was also evident: Śniadecki identified respiration as a process of absorption of oxygen from the air with the concurrent release of heat or "caloric". On the other hand, he declined to follow in the steps of his contemporaries who were exploring the role of electricity in living things, a line of inquiry stemming from the astonishing discoveries of the Bolognese physician Luigi Galvani in the early 1790s.[3] Galvani's revelation that electrical

2 Zacharewicz, Witold. *Jędrzej Śniadecki*: *His Life and Scientific Work*. Warszawa: Państwowe Wydawnictwo Naukowe, 1975, p. 16–24.

3 Śniadecki, Jędrzej. *Theory of Organic Beings,* § 202. — Further references, by paragraph number, are given parenthetically in the text. — *J. G.*

impulses elicited from frogs' nerves caused motion in the muscles of the animals' legs created a sensation among European physiologists. In Germany, it was seized upon by experimenters including Alexander von Humboldt and Johann Wilhelm Ritter. Their findings suggested that living matter was activated by electrical and other forces, a claim subsequently elaborated as a central plank of the *Naturphilosophie* developed by Friedrich Schelling and others.[4]

Śniadecki did not mention any of this. On the other hand, he devoted significant attention at the end of his first volume to the theories of the Scottish physician John Brown (1735–1788), whose widely influential medical doctrine came to be known as "Brunonianism" (§ 212–218). Śniadecki first learned of these ideas in Pavia, and would no doubt have heard more about them in Edinburgh, where echoes of Brown's teaching still resonated.[5] He acknowledged the doctrine as a precedent for his own, calling Brown's "the first medical theory, which goes back to the general principles of life" (§ 218). Brown had identified life with the activity of certain "exciting" powers, which are those Śniadecki calls "organic" or "vital". If they act properly,

4 Richards, Robert J. *The Romantic Conception of Life*: *Science and Philosophy in the Age of Goethe*. Chicago: University of Chicago Press, 2002), esp. pp. 313–321.

5 Zacharewicz, Witold. *Jędrzej Śniadecki: His Life and Scientific Work*. Warszawa: Państwowe Wydawnictwo Naukowe, 1975, p. 5; *Brunonianism in Britain and Europe* / eds. W. F. Bynum and Roy Porter. Chicago: Cambridge University Press, 1988, 104 p. (*Medical History Supplement*, 8).

these powers lead to good health, while defective or excessive action produces illness. But, whereas Brown had prioritized the nervous system in his account of bodily excitation and debility, Śniadecki pointed out that plants are fully alive though they lack nerves (§ 216). He therefore declared that a more comprehensive theory was needed, one that would seek to grasp the agency of vital forces in all living things. His ambition was to construct such a theory.

This was the purpose to which Śniadecki dedicated the first volume of his *Theory of Organic Beings*. He carefully distinguished the forces of organic matter from those operative in the inorganic realm, such as the familiar affinities governing the attraction of chemical elements to one another. He noted that the two types of forces frequently act in opposition. Chemical affinities act to tear apart organic materials when dead animals and plants are decomposed into their original components. Organic forces, on the other hand, counteract the forces of affinity as inorganic materials are digested to nourish living beings. Thus, the vital processes of nutrition and growth are governed by the organizational powers of organic matter, while the countervailing processes of excretion and decay are ruled by inorganic affinities. Matter constantly circulates between living and nonliving realms. Heat (caloric) is the lubricant of all these changes, breaking the affinities that bind matter together to assimilate it into living beings, and hence sustaining life itself (§ 77).

In common with other "vitalist" writers of his time, Śniadecki was careful to differentiate his theory of organic beings from the materialistic outlook of certain Enlightenment authors. He distinguished “organic chemistry” from the general science of non-living materials, introducing the term “organic chemistry” several years before it was supposedly coined by Berzelius (§ 81). He disavowed knowledge of how organic forces were originally created and denied that the power of self-organization was inherent in matter itself (§ 20). Living beings, and the forces that sustain them, owe their existence to a divine creator, he declared (§ 45, § 54). Although Śniadecki assigned human beings a position at the apex of creation, he did not follow Jean-Baptiste Lamarck in contemplating the transmutation or evolution of species. And, while he used the word “zoonomia”, he never mentioned the notorious materialist and evolutionist Erasmus Darwin, who published a book under that title in 1794 (§ 225).

The second and third volumes of Śniadecki’s text contained more conventional descriptions of human anatomy and physiology. Here he was more generous in citations of other authors, mentioning, for example, experiments on digestion by Spallanzani and Réaumur (§ 378) and on excretion by Fourcroy and Vauquelin (§ 399, § 406). He again took up the theme of respiration, citing the English chemist Joseph Priestley alongside his great rival Lavoisier (§ 342). Notwithstanding his general support for Lavoisier’s oxygen theory, Śniadecki was doubtful that absorption of this gas was what distinguishes arterial from venous blood; he did not believe that oxygen alone could sustain animal life (§ 349).

In the third volume, Śniadecki considered the nervous system, again distinguishing his position from that of Brown. He also mentioned the theory of the German anatomist Franz Joseph Gall about the localization of mental functions within the brain, though he did not endorse it (§ 465). Śniadecki described thinking as a manifestation of the organic powers operating in the brain and nervous system, further differentiating his outlook from a materialist one that would ascribe mental activity to the normal powers of matter (§ 463). He did however endorse the common belief of his time that qualities of climate shape the characters of individuals, peoples, and nations. He drew upon the authority of the Swedish naturalist Carolus Linnaeus for this idea, repeating Eurocentric prejudices about the superiority of people from the temperate zone over those from the tropics (§ 531). Śniadecki also participated in the general movement of the period toward more biologically-grounded notions of personal identity. He cited the Dutch anatomist Petrus Camper on the physiognomic differences between the human "races", and denied that Africans could acquire paler skins if transplanted to cooler climates (§ 536, § 539). He also discussed differences in physiology between men and women, claiming that moral and psychological distinctions between the sexes have a physical basis (§ 616–629). In trying to root racial and gender characteristics in the biological inheritances of distinct human groups, Śniadecki was very much a man of his time.

Śniadecki's *Theory of Organic Beings* thus presents us with the product of an ambitious and wide-ranging intellect, a man who tapped into all the currents of European learning while teaching on the fringes of the Russian Empire. He was deeply imbued with the medical and chemical sciences of the Enlightenment and the Romantic era. He sought to ground therapeutics in a fundamental understanding of chemistry, while distancing himself from the impious schemes of the eighteenth-century materialists. While ignoring his contemporaries' fascination with animal electricity, he shared their conviction that vital forces were responsible for the animation of matter in living beings. On this foundation, he built his medical doctrine, imparted to generations of students in Vilnius. The appearance of this translation, two centuries after the work's first publication, will allow readers of English to become acquainted with this remarkable and underappreciated man of science.

JAN GOLIŃSKI,
UNIVERSITY OF NEW HAMPSHIRE, USA

Translator's notes

A number of layers of the text can be highlighted from the standpoint of translation, namely: spelling and punctuation, lexis, sentence structure, text structure, and narration.

Spelling and punctuation reflects pronunciation differences between contemporary and early nineteenth century Polish language, for example, in Śniadecki's text "być" (to be) is "bydź"; "mieszać" (to mix) is "mięszać", or "skóra" (skin) is "skura".

From the perspective of contemporary Polish, Śniadecki's punctuation is rather erratic. The only correct usage is the usage of full stop [.]. Commas [,] semicolons [;], colons [:], and question marks [?] very often break the rules of contemporary punctuation, quite often all the rules of simple logic.

Quite often sentences are unnaturally long, separated by semicolons, where full stops should evidently have been used. The reason of this disarray, as I see it, is that the entire theory seems to be a written record of a live lecture. Śniadecki places a comma or a semicolon where, while speaking, he would have taken a breath and stopped for a second, or made a dramatic pause — this explains a curious use of punctuation.

The text is divided into paragraphs of different lengths. Some are very long, going on for two or three pages, some are short, just a third of a page. A striking feature of this text is the manner of addressing the reader. Śniadecki talks to his audience rather than writes for the reader, as if he was sharing a common space, not only intellectually, but in fact physically. For example:

"… *we* shall bring all this to light in the course of the following teaching" (§ 5).

"… *in our mind we* may attribute to them in common a certain power which, in the future, we shall call vivifying power" (§ 9).

"… *Let each and every one* ask their unspoilt minds and hearts whether it is possible to understand it and feel otherwise?" (§ 24).

Another argument to support the hypothesis that the text of the book is a written record of his lectures is the fact that his sentences are extremely long and complicated, interspersed by numerous commas and semicolons. The most disturbing for the translator is his manner of insisting on Latin syntax, shifting the verb (predicate) to the very end of the sentence, or to the end of the subordinate sentence.

There are words confusing for a contemporary reader because, though they sound Polish, they are no longer in use or their meaning has changed, such as, for example: *wiadomość* in the meaning of knowledge (contemporary rendering: message); *pobudka* in the meaning of a stimulus (wake up call) *bujać* in the meaning of proliferate (to swing) *początek* in the meaning of assumption (a beginning) Śniadecki is very creative introducing Polish neologisms which were to replace medical or scientific Latin nomenclature. Many exist until this day, quite a few dropped out of the dictionary. For example, he suggests replacing the Latin (and English) "placenta" with the word "miejsce", which means "place". My favourite is his translation of "microscope" — "drobnowidz".

His use of italics is interesting. Obviously, when he introduces a new term, quotes a foreign name, or uses a word in Latin he will use italics, but he uses this font also to abbreviate the phrase "for example" (*np.*), and always — apparently for no reason — when he says "*individual*".

His use of footnotes is very erratic. In Volume I Śniadecki more or less observes the numbering of inserted footnotes, but in Volume II and III he resorts to numbering his footnotes with no. 1, as if he wanted to say "just look at the bottom of the page".

Presenting his theory of living beings, Śniadecki postulates a certain consistent viewpoint, and returns to it throughout his lecture. He suggests that matter circulates in the natural world and talks of "viability", or the potential of this matter to feed animate beings and change them, so that the parts or organs they are composed of become more and more perfect.

" … Plants, bound to the ground, the air and water, feed on chemical combinations, converting them slowly to organic ones; their structure is fairly straightforward and almost similar in all parts. Animals, bound to the same conditions and, moreover, to existence of the plants they feed on, have a far more complex structure, usually consisting of many organic parts, quite different from one another" (§ 220).

"… Surrounded by raw or organized viable matter and surrounding ourselves with it, we acquire it incessantly from the air, from water, and other organic beings. Thus acquired, the matter passes through a number of organs which hand it over to one another and where, as a result of activity of various animal fluids, it is dissolved and processed, gradually embracing and receiving the animal nature of the being into which it is introduced. This constant uptake of viable matter and its transfer from one organ to another employs them all it and maintains their activity which constitutes their life" (§ 424).

He suggests that internal organs of the body are continuously "elaborated" and "dissipated" thanks to blood which is a carrier of viable matter.

"… circulation of blood and the fact that it reaches every organ and every living point is a way of supplying matter ready for elaboration everywhere" (§ 424).

"Therefore, those parts, directly or indirectly, can not be elaborated otherwise but from arterial blood. It must be a source of elaboration for muscles, nerves, membranes, vessels, bones, cartilage, etc., taking in blood completely or partially and transforming into itself according to the same original assumptions and laws by which nourishing foods are the source of elaboration for chyle and, subsequently, for blood" (§ 367).

Discussing the nervous system, he is in favour of the theory of phlogiston, and was not far from the truth describing electrical impulses, except for the origin of phlogiston (the air):

"… *Galen,* and along with him almost all the ancient authors, understood that the nerves were nourished by a particular element, or a volatile spirit which is born from the air drawn through the nostrils, and from the viable spirits brought from the arteries to the cavities of the brain, and from there spreads to all the organs" (§ 485).

Śniadecki lived at the beginning of the era we call Enlightenment, or the Age of Reason, centred on reason as the primary source of authority and legitimacy, and although he is in favour of creationism, he only once mentions God, in the context of religion being the source of illumination of "barbaric" people.

"The first, the purest and most salutary measure which alleviated the original barbarity of peoples and closes in certain bounds is *religion* which is quite a neural activity, exhibiting before man the greatness of God *absconditus,* His justice, the severity and goodness all in one, kindling the soul with hope of future life and the fear of its loss. Religion teaches fraternal love, illuminates the imagination with great and wonderful images, and thus leads to poetry and eloquence and through them, gradually, to scholarship and craftsmanship. Religion alleviates savagery and cruelty of warring nations; maintaining his nerves active, it sweetens" (§ 494).

Although Śniadecki places man on top of the ladder of creation: … "A human, from the standpoint of his physical aspect, is considered to be the most accomplished of organic beings, for there is none other, whose organs, functions, and actions are as complicated and astonishing; to his intelligence and his tongue nothing compares in all living creation" (§ 191), he admits that the origins of life are beyond understanding.

"It can not be any way to be in the power of the human mind to imagine properly and to understand how originally this creative force of shapeless and inert matter went into organic form…" (§ 22).

He acknowledges that "… there must have been a power or force, elementarily exerted on matter which shaped it into the firstmost organic form, and thus initiated life within it" (par. 20), and wonders "… What a perfect, splendid unity! What inconceivable greatness of the Creator who designed it! What strange quality of human mind which encompasses it!" (§ 523).

On a lighter note, he doesn't think much of women: "But this willingness to imitate is a truly animal trait, not only characteristic for humans, because it is stronger where mental powers are more limited, as we see in children and women" (§ 239).

Neither he does of artists: "The nervous constitution is not only characteristic of certain *individuals,* but of entire generations, families, and nations. All refined peoples, devoted to science and crafts, all rich nations engaged in trade, and therefore soft, all *individuals* leading sedentary life, namely, men of letters, woman, a major part of artists and craftsmen, all rich people, have this kind of constitution, acquired, if not natural" (§ 551).

Readers of novels and theatre fans are not on top of his list, either: "… Persons with this constitution have delicate and soft skin, weak and tender flesh, they fear slightest pain, shudder at every knock or scream, like long sleep; according to character or type of upbringing, they either love music or poetry, the theatre, romantic novels or, given to devotion, tenderly wonder upon the pleasures of future life" (§ 551).

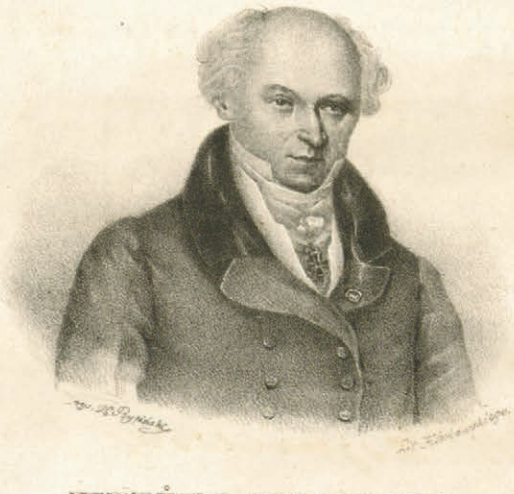
Neither are the lazy representatives of wealthy classes: "… In the age in which we live, especially in the more refined part of society, we see that ladies, spoiled and ruffled by the comforts of life, maintaining more intensive activity of generic parts, due to constant companionship and flattery of men, their whispers tickling female vanity and, above all, by perpetual recollecting of love scenes in theatres and romances or by fussing over the never-created events of romantic heroes and martyrs" (§ 630).

Śniadecki is fascinated by the beauty and harmony of nature: "… For in the whole of nature, as well as in the whole organic world, in every corner of the world, everything is interconnected: everything that is a result becomes a cause influencing general organism, organism of species or *individual* organism; every motion, resulting from preceding causes, becomes a new excitation for further movement and action. And hence, each and every step of progress in organisation and course of life must be a reinforcement and multiplication of active reasons: thus the very manifestations of life must be the cause of new transformations and manifestations" (§ 251).

He is equally fascinated by the potential of man, nature's best creation: "… The human genus has been developing and educating itself for ages, and one can not possibly guess what the limits of this improvement and enlightenment might be. Assessing the savage and crude state of man on the one hand, and his present education, level of skill and craftsmanship on the other, it must be truly astonishing to tell how far we have come to perfect and magnify our powers: casting a glance forward we need to humbly bow again, looking at the boundless field left for hope to flourish and the potential of endeavours of future generations” (§ 252).

For the translator it has been a fascinating adventure to feel the presence of the author day after day, to be immersed in his way of thinking and, in a manner of speaking, to live for six months in early nineteenth century Vilnius.

KRZYSZTOF MAZUREK



JĘDRŻEJ SNIADECKI.

Cenzor L. Borowski.

TEORYA

JESTESTW ORGANICZNYCH,

PRZEZ

JĘDRZEJA SNIADECKIEGO

RADZCĘ STANU, AKADEMIKA I PROFESSORA KLINIKI W CESARSKIÉJ MEDYKO-CHIRURGICZNÉJ AKADEMII WILENSKIÉJ, KAWALERA ORDERÓW ŚWIĘTÉJ ANNY DRUGIÉJ KLASSY Z CESARSKĄ KORONĄ I ŚWIĘTEGO WŁODZIMIÉRZA TRZECIEGO STOPNIA, CZŁONKA WIELU TOWARZYSTW UCZONYCH.

Tom I.

J. M. Paszkiewicz

WILNO,

W DRUKARNI DYECEZALNÉJ U XX. MISSIONARZY NA GÓRZE ZBAWICIELA.

NAKŁADEM RUBENA RAFAŁOWICZA KSIĘGARZA WILENSKIEGO.

1838.

K. Świderski

Let us all serve a good cause, and, inasmuch we may,
Work towards the common good.

JAN KOCHANOWSKI

With the Author's portrait

THEORY OF ORGANIC BEINGS
BY
JĘDRZEJ ŚNIADECKI

STATE COUNCILLOR, PROFESSOR AND ACADEMIC TEACHER AT THE VILNIUS IMPERIAL ACADEMY OF MEDICINE AND SURGERY, RECIPIENT OF THE ORDER OF ST. ANNA, SECOND CLASS WITH IMPERIAL CROWN, AND THE ORDER OF SAINT VLADIMIR, THIRD GRADE, MEMBER OF NUMEROUS SCIENTIFIC ASSOCIATIONS.

Volume I

VILNIUS
IN THE MISSIONARY DIOCESE PRINTING HOUSE AT OUR SAVIOURS HILL, PUBLISHED BY RUBEN RAFAŁOWICZ, VILNIUS BOOKSELLER.
1838.

It is permitted to print, subject to the condition that, after printing, the book is submitted to the Censorship Committee, and the number of copies is consistent with the Act of the Duma.
Vilnius 1838, on January 24th.

Censor L. BOROWSKI

PREFACE TO THE SECOND EDITION

Finally, I have lived to see the times when the Theory of Organic Beings *is beginning to draw the attention of learned physicians. And since the book is now out of print, I find it necessary to have it published again.*

Reading the text again I find nothing that might require improvement, addition or alteration. Extensive experience, attention to new inventions, insights, crucial analysis of opinions of others — all that is convincing me again and again that the science that I have expounded in this text is a true expression of nature and must remain as it is. It must remain as it is with regard to its principles and the conclusions. One ought to keep in mind that certain details, based on sometimes questionable experimental results, may change over time. But this, I prefer to leave for further experiments and comments. For example, the theory of animalisation which I based on Mr. Davy's *experiments, regarding lungs as the organ in which the most vital animalisation takes place, seems to have disintegrated following the experiments performed by* Messrs Allen and Pepys, *who claim that nitrogen does not merge with blood in the lungs. However, relying not only on the experiments of such a great Chemist as* Mr. Davy, *but also on such obvious elaboration in the lungs of arterial blood, so strongly animalised, I preferred to keep the entire fragment of teaching untouched until further experiments, repeated several times by prominent Chemists, invalidate or confirm that proposal. Other details, as I see them, do not need alteration.*

The theory of caloric, the origin of which the Chemists placed in breathing itself, does not appear to be complete because the activity of nerves, both in the origin and separation of warmth in the various parts of the body, seems to belong essentially in animals; only experiments, not solely done by Chemists but also by Physiologists, can settle the issue and establish scientific certitude.

It was indeed my first intention to adopt the fundamentals laid out in this book to provide ways of treatment consistent with my views, and to adapt them to treat people of poor health, but indifferent reception of what I had originally presented and emergence of new teachings — according to me erroneous but universally welcomed with great enthusiasm — have disconcerted me. Presently, my deteriorated health and inability to devote myself to such extensive work prevent me from engaging in such an enterprise. After all, my disciples whom I have led in the practice of the art of medicine, familiar with my assumptions, may replace me in the undertakings on this field in the future.

After all I have never had any secrets and all those who listened to me were well acquainted with my understanding of the essence of diseases and their treatment. It will be *for my own sake or for the sake of memories about me if there are those inclined not only to embrace and strengthen those teachings but further expand them with work and experiment.*

JĘDRZEJ ŚNIADECKI

PREFACE TO THE FIRST EDITION

It has been eleven years since, going through and debating various theories and systems I was familiar with, I looked closer at them and carefully considered their advantages and flaws. I suggested some ideas which constitute fundamental principles of science, elucidated in the present publication. At the time I did not intend to tackle such extensive work which I am now about to undertake, but primarily wished to collect scattered notes, arrange them in a certain order, and disseminate them in the scholarly world hoping that the fine grains would not be lost for humankind, and might be noted by the better minds, proliferating and giving rise to more important ideas and inventions. And, due to the fact that I was then living abroad, I decided to write the first draft of my work in Latin, enclosing it in a very lean publication which I entitled *Physiological* thoughts. Very soon came my return to the native land and, therefore, I had to abandon the intended printing of this minor work. Later, occupied by quite another subject, and continuously engaged in public service, I even lost the memory of this immature fetes which was buried in my manuscripts. Nearly two years ago it did again attract my attention. At the time of reading it, I felt both the importance and inadequacy of the work, and took it on board again but, with the view of a better and clearer explanation, I decided to write in my native language.

Beginning the work I soon realized that it would be more than suitable to extend my original intention, not only presenting the whole *Theory of Organic Beings* in general, but also employing the discovered laws to human life in practice, and thus laying out the entire science of human condition of health and disease, and the means to avoid or to drive out the latter, in accordance with the foundations of this teaching. Thus, I had before me the entire medical science, if not in its most detailed form, at least the essential parts. And although the magnitude of this intent may have insulted my natural reluctance to work, nonetheless, I decided to overcome all this and to see whether the art of medicine, presented in keeping with these assumptions, would change its form and to what extent pure reason could justify or condemn our actions in treating diseases or keeping them at bay. And first, in order to preserve a certain order in this venture, I divided the whole work into parts, the first of which was to contain only a general lecture on the theory of life of all organic beings, the second part focusing on the application of that science to describing human life in health, and the conditions of developing and relenting diseases, exposing the causes of such changes in health and general perspectives of prevention and, finally, ways of overcoming disease. The third and ultimate part is a systematic lecture on all the sufferings and ailments of man, together with an explanation of methods of how to overcome them.

I know that a great number of scholars are enemies of all theories and systems, indeed, of all reasoning in medical science; I am aware that ill fate of almost all explanation introduced in this domain can, to a certain extent, justify such a strict judgement. But isnt it exactly why this kind of thinking is deprecating in the eyes of a Medical Philosopher? Is not it a real disease of the human mind which degrades skills and delays progress? After all, without a well-founded and clear-cut theory there will be no real science. Furthermore, without science there will never be any medical art. That is why the better and more free minds extricated themselves from that wicked prejudice of a yoke put on science by the weak heads, and refused to carry it. One should, therefore, work on the theory of medical science, but to avoid the errors that our predecessors were trapped in, one should work at the same time in a philosophical manner.

So what will be the characteristics of true and perfect theory? These are as follows: *firstly*, such a theory should be based on experiments and observations — not of the nature which we see in abundance in almost all medical journals, or such that rare observers boast with, claiming that everyone else had missed them and only thanks to their acute perception were they noticed at all. I am talking about observations which are constantly and every day evident to the whole human race, and which every human being endowed with common sense and sensitivity will immediately take on board. *Secondly*, a true theory based on such principles should embrace all natural events and explain them clearly; it should awaken in everyone a strong feeling and a conviction that it is indeed so and not otherwise. Because, since nothing happens in nature in opposition to its laws, no natural occurrence should be found beyond the limits of such science. After all, it seems to me that the assumptions, being the foundation of contemporary science, shall withstand all attempts of sound criticism. Because, *first of all*, the fact that all living creatures inevitably need water, air, heat, light, and food to live, and without their aid will not survive not even for a moment can not be denied by anyone endowed with senses. *Secondly*, the fact that organization is a precondition of life, moreover, is inevitably necessary and attached to it is beyond doubt, since even the names of organic beings or those existing in the common language are taken as one. *Finally*, the fact that only a certain kind of matter is capable of upholding existence of living beings likewise can not be denied. If anyone wants to deny it, let them try to live for one day on sand, clay, or metals; may the gift of Midas of turning everything to gold serve them well for a few days. After all, whoever could overthrow the certitude of that assumption, would do the greatest favour to humanity because he would expel deprivation and hunger forever from the face of earth, the greatest source of unspeakable disasters. By removing the need for property, he would free the people from having to work, from government and any social ties; he would dry the well of virtues and evil deeds of the human race.

Whoever has accepted the three assumptions, will have allowed this my entire theory and, in spite of his will, has to pay homage to the truth.

Therefore, it seems to me that it is not so much out of self-love that I surrender the teachings in this publication to the learned world, but rather because of the strong sense of truth. I consider it impeccable in its principle, and capable of withstanding the severity of the harshest of judges. I admit that in the course of my reasoning, whose text is an uninterrupted thread, I could have indulged myself here and there, I could have allowed my impassioned imagination for too much, but that could be an insinuation concerning some detail or other but not the universality of science. Anyone, who has ever thought for himself, will know that extraordinary emotion and enthusiasm kindled by original and important thoughts is nothing new, and will easily understand and forgive the exultation which is natural in such cases. Regarding those who can not think for themselves and are unable to shake off the shackles of prejudice and bias, their opinion I do not value at all. They should not occupy themselves with reading this publication.

I should, however, safeguard good will and patience of those who want to apply their minds to understanding this science. Let them do not judge it in advance until they get well acquainted with it, let them embrace equally its entirety, as well as perfectly comprehend all the details. After all, in order to fully understand it one does not need any preparatory skills. Those familiar with the development of more accomplished physical sciences, those who have a general knowledge of chemistry, who can give good and healthy judgements about things in general are well prepared for the present teachings. Lastly, who has no knowledge of physics but, at the same time, has no prejudice and superstition, will easily understand and judge it. There is nothing simpler and easier than nature, and skills approach perfection and come closer to it and, the more they become easier, simpler and more obvious.

What kind of skill may be of more interest to a man than the art of medicine? This science, like other human sciences, has developed very slowly, compelled to overcome the infinite errors striving towards the truth with greatest difficulty. Rare geniuses, which this important area of knowledge had quite a few, at times contributed to its explanation and progress, at other times confused the truth and plunged it deeper into the depths of falsehood. Reading carefully through its history we can see that there is no other type of human knowledge that would undergo so much change, transition and shift. nonetheless, so far, the whole mass of skills could not be transformed into genuine science. The greatest talents, the clearest minds, who entered this dangerous scene with their work — often greeted with furore and applause — usually left it amongst mockery and discontent. Happy may be the one to whom at least the glory of a good actor was granted. Therefore, even though I regard the general *Theory of Organic Beings* laid out in this first volume to be certain and in principle unshakable, disconcerted by so many misapplied examples, I can only undertake to apply it to the art of medicine with the greatest reticence and discernment. For this reason, the subsequent three volumes of the present publication will not so soon see the light of day. After all, I expect that no one, convinced of the gravity and complexity of the project, will not blame me for that delay.

INTRODUCTION

1. — All natural things perceived by our senses can be divided into two great segments. In one of those we can see inert bodies occupying the space, though equally obedient to all external influences, but themselves incapable of any internal movement, not equipped with any source of transformation, therefore, such bodies which can exist by themselves, and if left on their own, they would remain intact and unchangeable through the infinite course of ages. Such bodies are called inanimate. In the other segment we observe bodies in which there is an obvious inner movement and a chain of continuous transformations; we can see that the existence of these bodies is transient, that they are born, they grow, reach a certain state of perfection and finally die, leaving behind and releasing to the world other similar bodies that replace them. Such bodies are called *animate*, *living* or, regarding their form, *organic*.

2. — A significant difference between animate and inanimate bodies is that the latter are in a perfect state of rest, and thus, separated from the influence of other bodies, throughout ages retain their proper and characteristic state. The other category of bodies are in the state of motion but, extricated from all other bodies, they would immediately

cease moving, and the motion could not be commenced anew. The content of the following lecture is going to show the difference very clearly.

3. — Organic bodies are usually divided into two classes, one of which bears the name of plants, the other the name of animals. Those found in the first class are bound to a place where they grow; they constantly improve, bear fruit and die deprived of power of moving from one place to another. The other class has the freedom of movement thanks to which they can change position and location in accordance with external or internal movement. In the course of this teaching it will transpire that plants are attached to the earth, air and water, and animals to the earth, air, water, and to plants.

4. — We also say that all organisms are *alive*. Life in the entire animate world depends on growth and constant improvement in organized beings who adapt and process, especially some of the surrounding bodies. In addition, in some plants and all animals there is movement and sensation. Some scholars even wanted to limit this movement, sensation and feeling to animals only, but they were wrong because movement evidently occurs also in plants, although not in all plants it is visible; regarding sensation and feeling of other beings, we can only judge it with limited certainty. Finally, what we imagine as sensation and feeling has been taken after ourselves and applied to animals in which the phenomena of life are very similar to ours, but the phenomena of plant life are far more distant from us, therefore, if

these beings felt, the expression would have to be quite different from the way we perceive feelings in ourselves and what can be seen in animals.

5. — There are, therefore, two phenomena characteristic of the animate world, namely *organization* and *life*. Both are better felt than described. They exist in ourselves, there are exemplified in thousands of beings which surround us. What do they depend on, how obedient they are to natural laws and forces — we shall bring all this to light in the course of the following teaching.

CHAPTER I

ESTABLISHING GENERAL FOUNDATIONS AND PRINCIPLES ON WHICH THE THEORY OF ORGANIC BEINGS IS TO BE BUILT.

6. — All animate bodies constitute part of the created world and belong to the greater whole which composes the universe, and are connected to the earth as an integral part of its system. All animate bodies who can offer themselves to our considerations are tied to the globe as a constituent of its general arrangement, and thus are bound to all other earthly bodies which inevitably influence their condition and state. And so, incapable of extricating themselves from those ties, they are *first of all* enslaved by all the physical laws which govern the terrestrial bodies in general.

7. — Nonetheless, independently of this common bond which embraces indiscriminately all matter, is not the exclusive sharing of life; living beings, by stronger and more intimate relations, hold to the bodies which surround them, that they can not live without their presence and without their help. There is no living being, as universal and everyday experience teaches us, which could survive alone and outside of the mentioned relationship.

8. — Nonetheless, not all the surrounding bodies have such a strong and real impact on animate beings; indeed, far greater part seems not to have any connection with them whatsoever. Those which are most essentially connected with life are: *air*, *water*, *heat*, *light and food*. Life of any animate entity ends immediately when deprived of them altogether, removing any one in particular entails an equally inevitable decline.

9. — This simple and sensible observation tells us that the mentioned beings must have some influence on the animate organisms: an activity owing to which such effects are produced. This mode of operation, whatever it may be, can be specific for each of these organisms, exceptional; those special relationships regarding animate beings will be discussed below. In the meantime, what is clearly to be seen is that there is a similarity shared by all mentioned organisms, namely that all are in harmony in maintaining life; in our mind we may attribute to them in common a certain power which, in the future, we shall call a *vivifying power.*

10. — Nobody can assess the establishment of such a property as ungrounded and proofless because, indeed, it merely expresses the fact that the mentioned beings are necessary to maintain life and, therefore, the expression is not limited to specific activities through which these beings could influence the living organisms; it only expresses the perceived undoubted truth they are needed to support life, and I do not expect anyone to be so unreasonable to apply this, or any other conclusion from the following lecture to the revelations of religion about spiritual life.

11. — And although each of these bodies has unquestionable nourishment power, nevertheless, this power is not equally strong in each of them. Light, for instance, does not seem to be as indispensable for life as heat, air, water and food; and in between these, denial of water and food does not end life so quickly as denial of heat and air. Other nourishment powers, specific to some living entities, and thus intended to discussed by us later, seem to have even less impact on life itself.

12. — A natural event, or rather a collection of events or phenomena in living beings to which we attach the idea of *life* must, of course, be at least partly the result of that power, which we called *vivifying*; and all animate creatures should be continuously nourished to be able to hold on to and sustain life.

13. — From the viewpoint of matter constituting all animate beings, considering their location (6), these beings should be regarded as physical bodies, and since viable beings also undoubtedly belong to the category of physical beings, life in the most general sense is the result of certain physical relationships between inanimate and animate matter. It is a certain way of existence of matter, and only in matter it can occur.[1]

1 This remark applies only to physical life in the strictest sense, and I do not expect anyone to be so unreasonable to apply this or any other conclusion from the following teaching, as to what religion reveals before us about spiritual life.

14. — Nonetheless, the very activity of viable beings does not constitute life in itself; aside from the fact that their influence on other inanimate bodies does not produce a similar effect, the living beings themselves — deprived from life even for the shortest time can not be revived again, and the nutritious powers lose their usual influence. There is no known example of any being, which has once lost its life and then was revived in a natural way, therefore, so to speak a life itself is needed to support life.

15. — This remark tells us the following: that the role of viable beings is not that they give or could give life to any entities, they support life in bodies in which life is born and to which it is given, so that life is not extinguished even for a moment, so that we can once and for all establish the following general assumption: *once life is kindled in any being, it can not be preserved and maintained otherwise than through an unbroken relationship between the animate being and external viable bodies.*

16. — And so, since viable beings maintain only the life that should first have been started, and continue to support it; what then is it that gives and begins life? In order to find an answer, let us consider whether there are other conditions to which life is attached, and what are they?

17. — So, *firstly*, life itself and the above-mentioned effects of nutritional powers occur only in *organized* beings; every living entity has organic composition specific to itself to which life is so attached that once severely strained or damaged it has no chance for revival. Everyday experience

seems to have convinced people of this truth so strongly that to damage and kill humans and other living creatures they have never used other ways except those capable of destroying organization.[2]

18. — If, therefore, organization is inevitable for life and activities of viable beings, what is its cause? What is its origin? Why is this organic shape so stable in *genera* and *species*, unchangeable and lasting for centuries? After all, the animals and plants described thousands of years ago are still quite the same today; although they give way to one another, they die and are reborn again, but always similar, always the same. Moreover, the phenomena of life, which are so different in various genera and species, in the same species are quite the same. So their difference or uniformity must depend on organization. What, then, holds organic shape uniform and never lets it change? What guards it?

19. — All animate beings are physical and material bodies, and this is why it can not be said that life or organization are inborn properties of matter or not separate from it since in we can see every day that matter itself, barely alive and organized, can lose life and its organic form and, indeed, it does. Then, it is dead and completely shapeless. So, organic form is not inseparable from it and can be removed

2 In perfect animals the bond of life and organization is striking. A strong blow on the head, wounds affecting bone marrow, especially at the onset, string heart wounds, etc., will end life momentarily. In less perfect animals and in plants this relationship is not so evident but no less certain.

and, therefore, matter is unable to give itself such form on its own. And, therefore, when it is organized and lives there must be some special force commanding it which arranges and binds this raw, shapeless and insensitive matter in an organic form. Let us develop this observation further.

20. — The property of self-organization is not inherent to matter; moreover, matter can not simply bestow self-organization onto itself — a question therefore arises: where did the said property originate from? The whole of animate creation is a collection of individual beings. We can see that each one has its own beginning and end; therefore might they, in their universality, not have had an origin? Inevitably. Provided that it is certain that matter alone is neither able to organize itself (20), nor kindle an organizing force, as such a force is neither inherent to nor inseparable from matter — it is not a condition bound to the essence of matter; therefore it has to be necessarily acknowledged *that there must have been a power or force, elementarily exerted on matter which shaped it into the primarily organic form, and thus initiated life within it.* What might such a transformation within matter have been, with respect to all organic beings, if not creation? Thence, all organic beings must have been elementarily created.

21. — And if it is certain that creative power is not to be elementarily found in matter, and that it was first granted at the time of the creation of organic beings, it must also be necessarily conceded that once the creative power has been granted it can not cease by itself, and that matter does

not have the power to dispose of it or destroy it from within. From it we may learn! *that the said power which was present at the elementary creation of organic beings, considering that it did convert matter into organic form, still persists and is preserved intact.* Which is, on the other hand, confirmed by a simple observation that as the same types and species of animal and plants persevere until this day, unchanged in their elementary forms, the cause of this persevering effect must also continue unvaried. And whatever this first cause may be, by virtue of all organic form being primarily dependent on it, regardless of any aspect of its nature, in the future I shall call it *organizing* or *organic*.

22. — It can not in any way be in the power of the human mind to imagine properly and to understand how originally this creative force shaped an inert matter into an organic form; so it will be above the limits of our knowledge, what is the organic force, and how it organizes the matter. Otherwise it would be tempting to grasp the creation. This will be one of the first reasons, about which science can only create suppositions. Therefore, either the organic power of the time in the organized entities is unchanging, its nature and manner of operation must be for us forever a mystery. So all the possible tests in this intention, all in this kind of guesses, are in vain and useless to be considered.

23. — The effect, however, of this great force — namely organization and life dependent on it — being constantly in focus of attention and experience, may express the true intention of science and, basing on attention and experience,

it will be possible to make judgments about organic power and investigate the laws by which it operates. Such laws of organization and life may, *firstly*, be universal and serve all organized and living beings without exception; *secondly*, be specific only for certain genera or species. *Finally*, distinctive. The second and the latter should be contained in the first and consistent with the first.

24. — No one should wonder why, as regards creation of organic beings and bestowing life to matter that I, not following the opinion of many serious scholars, had to resort to the first living beings and to their original formation by the creative power. Because, *first of all*, such a science is not a guess or an assumption, but itself comes from the presupposition of evident beginnings. After all, every natural cause must have its cause — is it not so that we comprehend all things that occur in matter basing on an assumption of existence of certain forces which urge matter to such transformations? Let each and every one ask their unspoilt minds and hearts whether it is possible to understand it and feel otherwise? Whatever there is in nature it must have a cause, primarily, even familiar causes are always the result of other, more elusive ones. This is why the entire human race, for centuries, addressing a shared sensitivity, resorted to the first root of creation of all things, seeking the most convincing proof of truth. And although some great philosophers tried to silence this prevailing feeling and weaken the resounding voice of truth, it strongly broke through their phantasms and conjectures, and that eternal truth could not

be plunged in the expanse of falsehood to which the human mind must have been exposed. And if people made so many wild and improbable conjectures about creation, should we attribute it to the uncertainty about the beginning? Or rather to uncontainable desire of the human mind to try to understand and explain things beyond our understanding?

25. — After all, when *Newton* through attraction explained the arrangement of the universe, incomprehensible before him, using the strange power he snatched the secret from nature, tied all the planets to the sun, tied all the moons to planets, and saw if, at the time of their conception, a force was not exerted which pushed them along a straight line, that this huge universe would be without form and movement, the circulation of planets around the centre to which they are attached might not have happened at all. And so, incapable of shaking off this once acquired push, they are forced to circulate eternally around the shared centre.

26. — On the other hand, we have come to conclusion that there is no way for the organic force, once kindled in matter to be extinguished, so once initiated life can not be lost in matter, nonetheless, universal and everyday experience tells us that living *individuals* suffer quite the opposite fate. We can see every day that all these individual structures are conceived, born, grow, perfect, and then, wither and fall to finally die. So, unbroken sustainability serves only organization in general; it can serve once created genera and species, and not extend to their members. This, in turn, tells us the following: although universal organic force

once kindled in matter can not be extinguished, in living *individuals* it is purely transitory and accidental, therefore, organic force can be granted to a certain mass of matter and then removed again. Accordingly, the organizing power ought to be considered in many ways — one of its aspects is impacting the matter in general, and in that regard it may be called *universal* or *total organic power*; another aspect is the proper specific to that or another genus or species of animate beings, and denoting the difference between one and another, and this can be called *generic* or *species specific organic power;* finally, as characteristic of an individual which I, consequently, shall call *individual organic power.* Actually, the latter should be of greatest interest to us because all animate creation, all genera and species sustain themselves; *individuals* often need aid to be sustained.

27. — However, when all the animate part of the world consists of genera and species, and the species of *individuals*, its behaviour must depend on sustainability and renewal of the latter, and each *individual* can not be perceived otherwise but as a part of a universal organization. whose proper commenced from its specific organic force and is dependent from it. Thus, each *individual* is governed by the following firm order: namely that *in every living being there is a certain power, specific to that being, originating from the first formation of all animate beings, which firstly initiates the organization of this being, then it sustains and perfects it, and the said being owes that power its origin, organic form and subordinate properties.* Above, such power was called *individual organic power* (26).

And since similar effects must always be induced by similar causes, matter can not be organized otherwise than by the primarily power, so wherever we observe the raw and shapeless matter adopting organic form and beginning to live, necessarily the activity of the organic force must be initiated and, on the contrary, where organized matter disposes of its older form, there the organic power must cease, fade and perish; where the organized matter transforms from one form into another replacement of organic power must surely precede.

28. — And all of this includes the following cases: *firstly*, as many times as a new *individual* initiates, so many the organic force must at least slightly precede the initiation of a new life. Therefore, the initiation of any *individual* is nothing but the initiation of *individual* organic power. *Secondly*, as many times as living beings incorporate inorganic matter from the environment and transform it into themselves, so many times *individual* power, specific to them, must exert influence on this matter. *Thirdly*, when some of the organized beings feed on others, then the first *individual* power must inevitably be replaced by their own. The first of these cases bears the name of *fertilization* (*fecundatio*) or *conception* (*conceptio*), and the latter *assimilation* (*assimilatio*). And all these processes, as dependent on the organic force will, in the future, be called *organic processes* (*processus organici*).

29. — And as we warned above that it is quite impossible to conclude what organic power itself is, how it binds matter and gives it a form of life, similarly, now we must

admonish that the present teachings or any other consideration can not reflect on how organic activities depend on the manner of this power being exerted.

30. — One can not attribute life only to organic power itself and only in the organic power seek the cause of such a great event or all phenomena occurring in the organized beings. For if this power, or its effect — organization — were to constitute life, then the *individuals* in whom power would be once found in the moment of first creation should themselves be capable of supporting life and surviving, and would need no relationship with surrounding bodies. If they were self-sufficient, there would be no reason for them ever to lose life and organization. And, as everyday experience teaches us, life of individual members of the animate world is transient, and without help of viable beings it can not occur, therefore, I hereby submit that organic power and organization as such do not include life of *individuals*, neither do they constitute it. What brings us back to the beginning of our teaching (15), whereby we have established that, *once life is kindled in any being, it can not be preserved and maintained otherwise than through an unbroken relationship between the animate being and external viable bodies.*

31. — To bestow the first impulse of life to any being means to grant it organic power from which its existence must begin. (28) So, connecting the principles of the present teaching with what follows, it needs to be said that: *the existence of every being depends on kindling life in it, but such an individual will not be able to organize itself and, thus*

live, *if viable powers do not instigate it to do so unceasingly*. Therefore, life of every individual must at all times depend on unceasing presence of the *individual* power and on continuous expression of viable powers.

32. — The *individual* power would be absent if it were to stop acting even for a moment. It should, therefore, by nature, in accordance to its destiny, exert itself constantly. Therefore, should it expire even if the shortest time — not being innate to matter, and therefore incapable of initiating and rekindling itself — without re-creation it can by no means be found. And for this simple reason if life expires in any living being even for a shortest time, there is no way it will return.

33. — And because in living *individuals* the organic power must always be exerted, and every event of its activity, every exertion thereof is bestowing, or at least an attempt at bestowing organic form to matter, so *all animate beings*, *living*, *uninterruptedly organize themselves*, that is, entire life is a continuous and never-ending organic process or a never-ending *assimilation*. This is the most important truth to which we can learn in the of science life, and which will be fundamental to our present teaching.

34. — Therefore, life of organized *individuals* is usually governed by the following conditions: a) In each animate individual there is *individual* power which should be exerted always and constantly; b) Each animate body should remain in constant contact with external viable bodies. Removing any of these conditions does not allow for a potentially

initiated life to begin, and ends the life which has already begun.

35. — We neither know the organizing power nor we know how it is initiated in *individuals* who are about to commence life, therefore, we can neither kindle it, fortify or alter it directly by any means. This is why this aspect is beyond our influence on the condition of *individual* life. Conversely, all viable powers, being a continual subject of experience and attention, able to balance the bill and dimensions, should draw our whole attention. Because of their superior knowledge and decent use of every organism, they will be able to govern and live in a certain way. This is the only way we can come to assure ourselves of any impact on *individual* life.

36. — Taking it all into account, because there are several kinds of viable powers and each of them, being applied to organic beings in a particular way, may display a specific activity. Therefore, *firstly*, the influence and affinity of each viable power should be recognized and appreciated, *secondly*, the connections between all specific activities, and the ensuing cases should be comprehended and calculated. And because this knowledge covers everything that can be learned about connections between living beings and the rest of the surrounding nature, excellent lecture about them should embrace a greater part of the theory of life. Let us then commence presenting this knowledge.

CHAPTER II

CONSIDERATION OF FOOD, BEVERAGE AND ANY MATTER IN GENERAL WHICH ENTERS THE COMPOSITION OF ANIMATE BEINGS. ANALYSIS OF MATTER IN WHICH LIFE AND ORGANIZATION OCCUR. ESTABLISHMENT OF VIABILITY, A NEW CHARACTERISTIC OF MATTER.

37. — All living beings, remaining in constant connection with the surrounding bodies, appropriate a great share of those and grant them part of their own specific organic power (28) transforming them into themselves, into their own bodies. Basing on common experience we can see, of course, that organic beings do not incorporate any accessible matter immediately, neither do they transform it totally into their own bodies, but in that respect they leave themselves a certain choice about which we shall learn and see that it is the following.

38. — All organic beings either feed on one another, or feed on matter which originates from dissipation and decomposition of organic entities, that is, either they themselves or their dead bodies serve as food one for another. Man lives on plants or meat, a large part of four-legged animals also live on meat, other on plants. Fowl in a similar way, either

feed on animals, fish, worms, or insects, also collecting plant seeds or grass for food. The same can be said about fish, bugs and insects. In addition, all animals need air and water to live, and in this they are in agreement with plants which can not sustain themselves without those two elements. But as for food, at first sight plants seem to be an exception to the rule, for they can not process organized matter for food, nonetheless, partly with roots in the earth, the trunk and branches in the air, they pump in moisture or other earthly juices and, using the power of their own organization, process them into food so much that water and air alone seem to suffice to sustain their life and, as it will become clear further on, it is indeed so. But more focused thought in this respect will teach us that the kind of matter which plants take from the air and soil, and process for their own benefit, is the same as that which serves the beasts as food.

39. — So, not all matter the globe is composed of, can be elaborated into animate beings. And although life in the most general sense is a resultant of certain physical relationships taking place between animate and inanimate matter (13), the major part of matter can not enter such relationships, therefore, it is not suitable for feeding organic beings and replenishing their detriments. All matter of this kind, in a large part, is submerged and hidden in the deepest innards of the earth, forming its nucleus; whereas almost all the living beings and all elements dedicated to sustaining and preserving their life cover and adorn the entire surface of the earth.

40. — Since only a part of the matter the globe is composed can serve as food to organic beings, and since all foods taken in by organic beings turn slowly into their liquid and solid parts and organize themselves thoroughly, since matter both originates from organized entities and is again transformed into organic entities, then such matter continually passing from some organic beings into others must entail conditions needed for life and organization which do not serve the other kind of matter. (39) In order to distinguish them from each other in this respect; we shall name the former *viable* or *nutritious* matter, and the latter *non-viable*, and all the bodies formed from the former, regardless of the fact that they are organized or not, shall be called *viable*.

41. — What is viable matter? What kind of matter is it? What elements does it consist of? This is easy to grasp and mark, remembering that matter either consists, consisted or will consist of animate bodies, and that matter comprising animate bodies must necessarily be viable. Therefore, properties which serve matter, elements which it can be broken up into, must be properties and elements of viable matter. Although bodies originating from it seem to vary significantly and, indeed, are often different, sometimes displaying quite opposite properties, matter is everywhere one and the same. This is proved by evidently easy transition of matter from one body to another and, finally, it makes chemical breakdown doubtless. In this day and age, when Chemistry can enjoy most precise analysis of organic beings we know that the elements making up in all organisms are the same,

and that their number is enormous. The entire plant kingdom lives primarily on water and carbonic acid, and it can be dissimilated into water and the said acid, that is, *carbon*, *hydrogen* and *oxygen*. All animals are composed of the same elements and *nitrogen* which is largely responsible for all chemical differences between animals and plants. And if sometimes the latter element occurs in plants, it grants animal-specific characteristics to plant matter or to matter in some of their parts.

42. — *Phosphorus* and *sulphur* can be added to these elements, both in the animal and plant kingdom, although these two are less abundant in organic beings, and may be discovered in only some of their parts. And although these two are very common in the fossil kingdom, they undoubtedly owe their origin there to organic beings, too. Phosphorus, for its curious flammability, has never been, neither can it be found in the fossil kingdom in pure form, but is quite abundant in the form of phosphoric acid combined with lime, iron or other basic salts. We often encounter sulphur in pure form.

43. — I have said above that viable matter always covers the surface of the earth, and spreads over it everywhere; non-viable matter occupies only deeper and less accessible innards of the planet, however the former, just like the latter, is subjected to the power and laws of chemical affinities, and they often bond, thus giving rise to various chemical products. Those of the bodies which can be dissimilated into nourishing elements should be regarded as wholly viable,

and are quite suitable to sustain life and growth of organic beings. These are air and water which cover the upper crust of the globe, and in which all organic beings dip and live. The earth, which appears to sustain and feed all plants can not itself be regarded as a nourishing entity, but being a sheath of all plant and animal carcasses, separating them, facilitating their slow and imperceptible decomposition, passing and trapping air and moisture; swallowing oxygen from the atmosphere, incessantly creating carbonic acid, is a rich store of nutritional substances and, so to speak, both a depository and sieve filtering and separating matter so that plants can always draw from this abundant source and turn it to their own use.

44. — Animals, whose organic composition is more complex and far more sophisticated than that of plants, may feed only on pure viable matter, so the matter which has once found its way into the earth and separated into elements which have mixed or chemically bonded with non-viable matter, would be forever lost for them, for the organization, and for life, if plants did not extract it anew and transform it within themselves. In the first case, more and more nourishing matter would surely be lost to animals, and nothing could compensate for it so the animals, gradually decreasing in numbers, would have to disappear completely in the end. Plants sufficiently redress it, and are an important organ for sustenance and preservation of animals, an inevitable condition to which their being is attached, because once dissimilated organic matter can not return to animals other than through plants.

45. — In this way, viable matter passes from the soil, air and water to plants, from plants to animals, who again return it to the soil, air and water. Only here, decomposing slowly into elements, mixing in various ways with non-viable matter, succumbing to the power of various chemical affinities, it gives birth to a plethora of bodies, and often produces astonishing natural effects. And not all plants are converted to benefit the animals, their great number, either completely or partially, end in the soil. There, the remains of plants mix with animal carcasses and fossils and engage in interactions. No wonder, therefore, that viable matter is destined either by the first Creator of all things to dwell on the surface of the earth, and to continually organize itself, often in various bonds with non-viable matter, and is found in quite deep layers of the earth. The more so that in the unbroken course of centuries the globe has undergone tremendous changes and revolutions so many times since the beginning of creation, moving its innards several times and changing its entire surface, it was easy to destroy whole generations of organic beings, crush them and bury deep in the ground.

46. — No wonder, therefore, that when visiting the depths of the earth accessible to us, we come across vast layers of organic remains which are too far away from the surface of the earth to be extracted by plants and restored to organic form. Their path to life would be forever closed if nature had not invented other means to extricate and throw out huge masses from the bowels of the earth. We shall dwell on that subject in more detail elsewhere.

47. — The conclusion of what we have said so far about nourishing matter is as follows:

Firstly, since matter can change organic form so easily, and passing from one living entity to another finally circumnavigates them all, since chemical analysis shows that in all living beings there is the same matter, therefore, as such it must be indifferent to taking on this form or another, always ready to assume such as determined by the organic force to which it is subjected. If it had in itself such power of organization, it would transform completely into one or another form forever. Therefore clearly, *viable matter has no power to organize itself on its own,* and such power is extraneous to matter and totally alien to its nature. To strive for all possible organic forms is the same as not strive for any one in particular. And so, all these systems coined by philosophers who have assumed a similar property in matter, who supposed and conveyed the impression that organic beings could emerge on their own, sticking together and growing like salt crystals and collapsing on their own accord — these philosophers do not even deserve a *refutation*. It is obvious, if we are to be true to the established assumptions, that the organizing power is additional, alien, external, and has nothing in common with the nature of matter itself.

48. — *Secondly*, because only a part of the matter that makes up the globe can live and organize itself, and animate beings serve as prey and food for one another, clearly nature intended to curb the number and reproduction of animate beings by imposing certain limits on them. In this way,

one living being can arise only by the fall of another, not otherwise; some species of animals or plants can multiply and spread only by preying on, oppressing and destroying other species. Therefore man, who spreads and multiplies all over the earth, is the greatest oppressor and killer of other organic beings. For the same reason population itself must have some limits. If our tribe ever surpassed them, we would have to turn against each other like predators. Let's look at sparsely populated or deserted lands — impenetrable forests everywhere, vast areas of vegetation, insects and wildlife in abundance covering the surface of the land. Let man visit them only once, let him begin to settle in and multiply, then the towering tyrant of animate nature will slowly and imperceptibly begin to destroy everything, transforming everything in the ways of his own tribe so that, over time, villages and large cities will replace forests and the favoured habitat of wildlife. Then the same matter that once was part and served the lives of these weak creatures will slowly transform into man, or into creatures serving and nourished by him.

49. — *Finally*, it is clear, remembering our assumptions, that matter almost constantly and intermittently lives, passing from one organic beings to other, and then circumventing all. If it happens to free itself from organic power, and rests for some time, this rest is transitory and relatively short. Such matter sooner or later attacks again other animate beings which assimilate it and thus bring it back to life. And because life takes place in all organized organisms,

though in every particular organization it arrives in a different manner, moreover, viable matter is capable of taking in all life forms and, indeed, it does, so we must admit that life within the general system of the world is allowed only in this matter, that it is its true and undeniable heritage and its true property. Indeed, this property can not be attributed to non-viable matter, because it has never been seen in the state of life, because no organic being feeds on it and can not make up for the detriments of its own organization. It can not be attributed to animate *individuals* because their lives are transient and temporal, for they are only allowed the power of forming and processing viable matter, and for a short time, when matter moves from one form to another, lives either eternally or time and again in another form. This property of life can not be even attributed to *genera* and *species*, for their permanence from the first creation of animate beings has not been so far unbroken and is protected forever; for each one only a certain organic form and a certain *modification* of the organic force has been secured, whereas life has been equivalently protected. So we can rightly distinguish this property of matter from all other properties. It does not constitute life itself but an indispensable opportunity for life to emerge, therefore, in the future we shall call it a property of *nutrition*.

50. — Such a property of matter makes it possible and means for matter that it can organize itself and be obedient to organic powers. I can not expect anyone willing to deny this property or have the slightest doubt about it. If they do

deny it, let them answer, why not all matter comprising the earth is capable of organizing itself? And if they can explain a cause of this undeniable event, doing so they will agree with me, and will only oppose a title as such. It is not easy to answer the question whether this property is equal and uniform in all viable elements and whether it has its degrees and divisions. Taking it all into account we can say that not all viable elements mentioned above are to be found in all organic bodies and in equal abundance, so not all can boast this property in equal degree but being stronger in some, in others displaying extreme weakness, its strength decreases gradually. And even if this property was to be found in all matter, but so that in some natural elements it was most powerful, and in others almost non-existent such a supposition would not change the essential principles of current teaching.[3]

3 It seems that nutrition is not equal in all elements. It can not, for instance, be denied calcium, silicon, magnesium, potassium and sodium. Calcium, for example, as a constituent of bones and shells, is a splendid part of organic beings. Calcium is to be found in the fossil kingdom, and it seems to owe them its origin. Nonetheless, it can not be as viable as hydrogen, oxygen or carbon. The same can be said about potassium, sodium, silicon and magnesium. It seems that some metal compounds serving those bodies as base are created in plants, what would make their uncomplicated structure sound doubtful. Experiments, or experience only can confirm or deny this supposition.

CHAPTER III

CLOSER CONSIDERATION OF LIFE. IDENTIFICATION OF THE WAY IN WHICH EXTERNAL POWERS NURTURE THE QUIESCENT POWERS.

51. — Physical life is, thus, an unquestionable inheritance of matter (49), it is the result of certain relationships between animate and dead matter (15). But this heritage does not serve the entire material kingdom, being only a quality of some of the natural elements which we have called viable. On the other hand, not all dead matter is capable of viable; this property is limited to a few elements which are inevitable to all life (8). Among them air, water and food comprise viable elements and, therefore, once assimilated into organic beings, they will completely or partially yield to *individual* power, and transform into bodies of those beings. And though many less viable beings such as soil, major part of salts and metals can accidentally or deliberately penetrate into living bodies and have certain effects on them, instigating certain activities. Nonetheless, all such beings, firstly, as not playing a role in sustaining life, should be considered quite unnecessary. Secondly, as unable to be obedient to organic power, they behave differently towards organic beings,

they must act quite differently compared to viable beings, and can not presently come to our attention.

52. — Therefore, with the sole attention on beings indispensable to life, it must be postulated that both what is alive and what nourishes consists of viable elements. Therefore, life is the *resultant of the interaction between non-animate, or non-organized viable matter and animate and organized matter.* Life is a property of viable elements and can only occur in them. And because these elements penetrate into organic beings, they yield to the power of their *individual* strength, and little by little change into their bodies, so the matter viable organized beings is, in turn, organized by them, and the activities taking place at that time are interrelated. And because life of every being depends in particular on continuous activities of organic power and viable powers, and the resultant of this interaction is feeding the organized matter, and organization of newly introduced matter, *so every living being is constantly organized, and life depends on nutrition and continuous organization of the feeding matter.*

53. — In addition, due to the fact that life can not be sustained otherwise than by continuous feeding, and this occurs via viable matter, and because this matter is subject to exertion of organic power — and all animate beings undergo a constant process of organization — therefore, every act of nutrition must correspond to a proportional contribution of organic power, in other words, to organization. Thus, every act of nutrition will be an incentive for organic power to work, and every exertion of power will be equivalent

to organic activity. So, for life to continue, it is necessary that living beings keep organizing themselves incessantly and, in order to be able to organize themselves they need to be stimulated by continuous supply of foreign viable matter. As we have established earlier (31, 32), *individual* power must be constantly active, and since this activity depends on the continuous organization of viable matter, once the power has organized the entire matter within its circle, it ends its activity, which brings an end to *individual* life. For it to happen, it is necessary that the power is constantly exerted on different parts of matter, hence for sustenance of *individual* life constant replenishment of matter is necessary. Consequently, there is a need of viable powers. This is why complete insufficiency of such power, even if instantaneous, ends *individual* life forever. This is the eternal and immutable law of nature, this is the mystery of life, this is what viable entities have in common, this, finally, is the fate of all beings. Life without the help of the former is nothing.

54. — Moreover, because the laws of nature are indispensable, they tolerate no exception because nothing can ever emerge from them; Such is the law prescribed for every living creature; its life must end at this moment when organization and absorption of viable matter stops, so all the activities, efforts, attempts, thoughts, in other words, the very direction of every living creature is aimed only at absorbing as much viable matter as possible and ensuring its use. The life and sustenance of plants finds its certitude in the structure of nature itself; for such is the character of the surface of

the earth from which plants pump their food that that it is almost never short of viable matter; such is the constitution of the atmosphere that it provides plants with vital elements, and soaks the soil with ample moisture. All animals are constantly engaged in searching, gathering, and securing their own viable matter; they are at war for fodder, they destroy and devour each other. This is the ultimate intention, the true cause of all human endeavour and enterprise, and it is the real source of his industry which grows or falls down as he sees fit; this is the reason for his greed, jealousy, ambition, and the desire to exalt himself and be above others; in a word, the reason for all his passion and agitation. Philosophers intending to define moral laws of human activities should start their observations just there; sensible legislators should never lose sight of this view. Because, finally, experience of so many previous centuries has shown that it is impossible to transform and change man who must always be the way he was formed by the hands of his Creator; that his personal behaviour and personal interest will always steer his actions, and that all education is only about enlightenment, to show a man where his real interest lies. Therefore only those are true friends of the human race who seek to enlighten it.

55. — Consequently, if viable matter can live and organize itself in living beings, then this matter, by the power of nutrition, must seek to live and succumb to the organizing power wherever it is found. For example, bodies tend to come into contact with each other by the power of attraction, similarly, they tend to recombine by the power of affinity. For

if the elements experiencing organic power were completely inactive in that respect, then this inaction would serve matter in general and, therefore, all created bodies could live and organize themselves; each might be food to all organic beings; every living being would be capable of emerging from them and could process itself, but all that is contrary to experience. Due to the fact that the viable elements are identical in all genera and species, so by the power of nutrition, they generally tend to live and organize themselves, but since part of them come under the power of some *individual*, then the *individual* power gives a certain direction to this general tendency, hence the *individual* and local form, hence the kind and manner of life. Every individual organization, therefore, is the resultant of two tendencies: one is universal, rooted in matter itself, by the power of which some natural elements strive to live and organize themselves in general; the other is specific, rooted in *individuals*, which signifies this kind of life and form of organization.

56. — Thus, the particle of viable matter that has experienced certain *individual* power partially or as a whole, and which is already partially animate because it did not cease to be viable, must by the power of that property strive for further life, and take on all similar organic forms, except for the one which it already possesses. Applying it to a completely unorganised viable matter, which strives equally hard for all forms, naturally, it must be less nutritious, and this reduction must be equal to a pursuit for that particular form in which it has found itself in a given moment because the pursuit

in question already saturated and satisfied. Considering the nutritious elements in general it is worth noting that those less organized are less nutritious compared to other similar ones, which are in the state of complete disintegration. Hence, the general claim that viability is a property of matter which can be intensified, reduced, and saturated. This reduction, nonetheless, in each case, applied to the entire creation can be marginal and sometimes so small that, unerringly, it can be considered as nothing. Being in every case equal to the small part which an *individual* will be able to eradicate; if this *individual*, compared to the entire creation, can be considered too minute, then this particle in the same respect can be regarded as minute.

57. — The thing is quite different in case of *individuals*. The more organic power a given matter gets from them, the more viability it loses, *so that the viability of matter in the individuals remains*, *for them*, *in a reverse relationship to organic power exerted on matter*. In other words matter, which is incorporated in organic beings as their building material loses so much of its viability as much *individual* power it gains, therefore, in the same ratio in which it assumes a given form, it loses its potential. If, therefore, matter becomes completely organized and experiences the totality of *individual* power, it will altogether lose viability with respect to that *individual*. And when it happens, organic power will lose all its impact on that *individual*, and matter will be found in the body of the animate being as non-viable and inactive and, consequently, only fit to be excreted beyond its limits.

58. — Because self-organization is constantly under way in all living beings, therefore, part of the matter which they incorporate once in a while ceases to be viable and comes out of the influence of organic power. Finally, that power must constantly be exerted, and when it ceases to be active, it ends the *individual* existence. In order for life to continue intact, new matter should be supplied at the same ratio in which its certain part loses nutritional value and leaves the realm of influence of *individual* power, thus compensating for the lost viability, and should direct the action of that power onto itself. Hence, we learn that *individuals are incapable of preserving their lives if not for incessant replenishment of matter which constitutes them.*

59. — Consequently, when acquiring viable matter from food, water and air, animate beings must lose it at the same ratio, and expel it beyond the limits of their systems. Indeed, as everyday experience shows us, they constantly receive foreign matter and incorporate it, the same experience teaches us that, in the course of their lives, they discharge it out in various excreta. Indeed, more urgent and accurate experiments have shown that in adult and fully formed animals so much matter wanes in various excreta as much is acquired in food, drink and air over a period of time. And that is strangely in accord with the assumptions of the present teaching. Plants are not much different from animals in this respect, either, as we have seen. They not only absorb viable matter, but also lose in the same ratio, as evidenced by the damp vapour they exude, oxygen they give off in sunrays,

and carbonic acid they produce in the shade and, finally, their smell.

60. — From this we learn further that animate *individuals*, constantly replenishing matter that they are made of, form themselves from different matter all the time, but always from the same elements, and even in the same proportion.[4] The essence of *individual* existence, therefore, can not consist in viable matter, because the animate being replaces it constantly, nor in viability, because although viability either decreases and dies in self-organizing matter, newly arriving viable matter compensates for it and returns at the same ratio. In addition, viable matter characterises all living beings, so it can not be a property of any one in particular, therefore, it must be located in organic power alone.

61. — Matter, therefore, which has fully experienced *individual* power is not viable anymore (57) and this is why it is expelled beyond the limits of a being where it has found itself. All *excretions* (*excretiones*) of organic substances, being *individually* non-viable, can in no way serve as food, drink or any other way to those beings. Indeed, this applies even to genera and species because in *individuals* of the same species organic power is nearly the same, and in the species of one kind it is similar, therefore, matter which in a

4 In order to know and calculate in which time the entire human machine or any organism is transformed, one should be able to perfectly assess all the excretions and apply their general mass to the entire machinery. Then, the same calculation should be applied with respect to each individual organism and, finally, subtracted and compared.

given being has experienced *individual* power, can not serve as food to other *individuals* of the same species because for them it is entirely non-viable. This is why no animate being feeds itself on what is similar to it.

62. — Moreover, because genera can be drawn more or less close to one to another, too, and all together represent only different links of the same chain; because life, advancing along all these links, perfects further, therefore, the more one genus organization advances and distances itself from another, the more matter being part of the former will be less viable the latter. And this observation tells us that because animals only feed on organic beings, each of them in particular, or matter taken from it, must differ in the degree of nutrition with respect to a given *animal*; just like the matter of a given organic being will differ in nutrition with respect to different animals. In general, the more advanced the organization of one being, which is to serve another as food, and the more distant, the less viable it will be with respect to it and to the reverse. Summarizing, *the viability of organic matter which is to serve as food will be in reverse relation to the advancement of organization.*

63. — Therefore, in view of the fact that some viable elements are continuously acquired by organic beings, while other elements leave organic beings at the same ratio and, considering that viability is a property of certain elements by the power of which they strive towards self-organization and towards appropriating the organic force, consequently, viable matter continually circulates in organic beings, they

give it to one another, therefore, every *individual* may be considered to be a centre of such motion, whose nature depends on viability and *individual* strength. Finally, the said nature, in every particular case, will be such as the nutritional strength and *individual* condition of the organic power will determine.

64. — Because the newly arrived viable matter personally experiences organic power, and animate beings lose viable matter at the same proportion in which they acquire it, so at the same ratio in which newly arrived matter assimilates and organizes; once assimilated and organized it must be processed, replaced and disorganized. In fact, if we turn our attention to the experiments for a moment, we will find out that all plant and animal excretions, though consisting of viable matter, are completely shredded and disorganized. All plant discharges end in moisture, oxygen and carbonic acid. Animals exude water and carbonic acid through their lungs and entire surface of their skin, they dispose of water with an addition of phosphoric acid, urine and various salts; through bowels they discharge a shapeless mass known as *excrement*. Urine, however, and animal *excrements*, does not consist any organic matter from the viewpoint of compounds and constituting elements, but still possess many animal characteristics. The sources of origin are responsible for the above, as well as for retaining some combinations occurring in organic beings.

65. — And so, each arrival of viable matter in the organized *individuals* corresponds to its proportionate reduction;

every assimilation corresponds to proportionate compensation, every organization corresponds to proportionate disorganization. Furthermore, no organized being can live without continuous, uninterrupted union with surrounding organisms (8), because life is a resultant of activities of nourished and viable beings (13); these interactions of arriving matter depend on nutrition of the organized matter. From the viewpoint of the latter they depend on organization of the former and, finally, life is a continuous organic process, i.e., a continuous and uninterrupted assimilation (33); so *individual life will depend on the continuous organization of the newly arriving matter and proportional decomposition of individual's own matter.*

66. — Looking more closely into the cause of such replacements we can see, of course, that organic force which should be exerted all the time is essentially the source, and should it cease exerting even if for a moment, individual existence would end forever (32). If a certain mass of matter is organized and, so to speak, saturated, it needs new matter to sustain its further activity. So, all life organizing activities depend primarily on the power of organisation, and that power is the reason why animate beings need unbroken relationship with surrounding organisms. So, the assimilation, and any other process of creation of organic matter (*secretiones*), will also depend on organic force. Organic decomposition, on the other hand and, therefore all kinds of *excretions* (*excretiones*) depending on it, can not be attributed to the same power, unable to bring about two altogether opposing effects, thus the other part of life must depend on viable powers. We can, first of all, claim that generally, *to nourish is at the same time to disorganise, and external viable bodies nourish us in no other way, but striving to dissimilate and to decompose.*

67. — All impact of external viable bodies on organized beings strives to their decomposition, all efforts of the latter strive towards assimilation of the former. Thus, the action is reciprocal; and life is suspended on the reciprocal *action* and against it. So, every *individual*, every organic part, loses so much of its own self as much as it assimilates from the foreign beings. There is, therefore, incessant and reciprocal interaction between viable and animate matter on which life in the system of this world depends, indeed, since life in general is a property of viable matter and can not occur without organization; matter is urged by the power of nutrition to surrender and, so to speak, urged to appropriate the organic power wherever it sets upon it. And because by nature it strives equally towards all forms and, organizing itself, loses viability with respect to the form which it acquires, so by the same token it must gain the more form with respect to others. Finally, having lost the drive to assume the form in which it finds itself, and having gained the drive to other forms, it must attempt to remove the present incorrect form. The attempt to gain viability must be equal, on the backdrop of other organic entities. Its effect multiplies thanks to newly arriving matter, in relation to the effort caused by taking on this form. So, viability is a significant

cause of matter at times organizing itself and at other times undergoing decomposition.

68. — Reflecting on the fact that every type of matter in general always remains in a certain shape and succumbs to some natural forces, moreover, in the general arrangement of the world, its formation and manner of existence depends on the nature of these forces; the organic power exerting on matter is to give it a new shape and a new way of existence, it should be noted that this effect may not and will not appear earlier and in any other way, but when this new power has dissolved and eradicated the previous form and, consequently, by surviving it will surpass the powers which have given rise to it. *Firstly*, the organic powers can overcome those other powers and bring then to nil. Then, matter will be obedient only to them. *Secondly*, they may themselves withdraw under the influence of such forces, be completely wiped out by them, and then no organic action may occur, and all other action under way must disappear and perish. And, *finally*, these forces may merely weaken one another and separate, so that viable matter while self-organizing will be partly obedient also to other natural forces, and its organic presence will be a resultant mutual and reciprocal application of all the forces. All such forces, in order to distinguishing them from organic power — a vital cause of *individual* life, shall be called *quiescent or counter-organic forces*.

69. — The forces which can resist the organic powers are, *firstly*, all physical forces granting another endeavour

giving direction and thus *attraction* to viable elements, by which all particles of matter strive to meet and come in to contact with one another. Because this force accumulates, binds, crystallizes all matter it will often, in such attempts, be able to resist and oppose the organizing forces. There are *affinities*, by the power of which particles of different organisms tend to combine, and thus to form new organisms in different shapes and with different properties. Organic power almost always replaces, modifies and transforms such chemical compounds. *Secondly*, the same organic powers, or organization itself, must resist newly arriving organic powers because every genus and species of animate beings, equipped with their own specific organic power, if they are to serve as food to another genus or species they must, first of all, lose their life and form, and thus new power should override the old one and redo its entire creation.

70. — We can thus see that the beings which put on weight, which utilise other organic beings as food, attempt to take their lives first, and completely or partly wreck their organization, and all actions previous to digestion and assimilation of food are focused only on this purpose. We observe, furthermore, that animals, when capturing other beasts for food, before taking their lives, tear them to pieces with their claws, beaks and teeth, chew and grind them to pulp, moistened and softened by saliva, and further break these parts up so that, before reaching the stomach, merely a trace of previous composition remains. Man, not settling only for the ways nature has offered him, multiplies the number of

such preparatory actions by his industry and wit. Cooking, baking, cutting, chopping and the like, are performed only with this intention in mind. Even digestion in the stomach and intestines, production of white juice, and its further transformations in the milk vessels, conversion into blood in the blood vessels and lungs should be understood as mere introduction to a variety of other assimilations. All innards, every organ, and every part of the living machine renews itself and produces from blood what is needed, using blood as intended and capable storage.

71. — Plants, never feeding on entire organic masses, but merely assimilating final and dissimilated elements, living almost completely on water and carbonic acid, do not need so much introductory preparation; soil alone is enough to satisfy all their needs, therefore, soil can be regarded as a real pantry and kitchen for plants. In addition plants, never utilizing anything alive as food, do not need to overcome organic power; nor the force of *concentration* can put up much resistance against them as it is very weak and easy to overcome in water and carbonic acid, so far that they have to deal with only with mere affinities. An important difference between plant and animal beings is that plants, living on the simplest and most unstructured viable matter, in order to assimilate it will encounter resistance only from affinities, whereas animals, feeding on plants and other animals, are less hindered by affinity and much more by the earlier organization. If, therefore, organic strength was to be assessed and measured by the resistance it has overcome, then

it would be necessary to assume that it is weaker in plants than in animals, and between the latter it is the sturdiest in those which can feed on the largest number of organic beings. And, indeed, it could be so that organic force being the weakest in the simplest plants, grows gradually with respect to the perfecting organization, and in the animals closest to perfection is so strong that it ensures their domination over the whole animate world.

CHAPTER IV

AFFINITIES. THEIR WAY OF PRESENTING IN ANIMATE AND INANIMATE BEINGS. THE NEED, MANNER OF OPERATION AND INFLUENCE OF WARMTH ON ORGANIC BEINGS.

72. — The natural force, the power of which makes entities of different nature strive to combine, and with the help of which they are joined, transforming into completely new entities reflecting the elements they consist of, is called *affinity* (*affinitas*). This power of, as generally the servant of nature, should be present and active everywhere, and practically the whole chemical system of the physical world must depend on affinity.

73. — To surmise the nature of all natural and artificial compositions; to analyse complex beings into their elements and explore their properties; to know and identify all their related affiliations is the intention and employment of a Chemist. And since all such compositions and analyses of entities depend largely on the power of affinity and can only transpire with its help, therefore, it is this force which is the first object of his attention and a precision organ he uses in his work and activities. All of the fundamental knowledge

about this force should be drawn from Chemistry and all, as I see it, may be concluded in the following principles.

74. — Firstly, experience has given us a strong conviction that affinity is not equal between all entities.[5] It can not bring into effect any combination save for the smallest particles of particles that are not subject to perception, neither their size can be debated.[6] That the reason why this affinity is stronger in some entities than in others is not familiar to us, nor can we guess anything about the power of their affinity from the previous knowledge. Finally, I can say that a combination occurring by the power of affinity, changing the state and manner of existence of entities, must be considered to be a violent state, moving them from their former state of rest and manner of existence to the new form of being. Hence, I suggest that the force of affinity is unable to combine entities, not before it overrides all the forces holding an entity in its former form and state of rest. Such forces, therefore, should be regarded as resisting the power of affinity, and attempting to hold on to their first creation — namely rest — intact, and defend it against the combination to occur. This is why all such forces in general, having called

5 *Poczatki Chemii* [Sniadecki, Jedrzej. *Poczatki Chemii stosownie do teraznieyszego tey umieiętności stanu dla pożytku uczniów i słuchaczów ułożone y za wzór lekcyi akademickich słuzyc maiące*. 2 vols. Wilno, 1805. — *Origins of Chemistry*].

6 *Ibid.* § 12.

them quiescent forces I have established[7] that *affinities or forces effecting combination*, because there is no difference, *remain in reverse proportion to quiescent forces.*

75. — As for the recognition of such quiescent powers, it transpires that these end, firstly, in *cohesion* (*cohaesio*), which resists affinity the more effectively to the stronger it is; and, secondly, in resistance to affinities, by the power of which previous relationships hold together. If we direct our attention to organic entities, which incessantly acquire viable matter, we can see that in them affinities struggle with organizing powers, as with those which are to process viable matter into quite another form and different way of existence. These two forces struggle against each other the strongest in plants (71). The consequence of two opposing actions is either that the organizing force overcomes all affinities, and then no chemical compound will present itself in the organized being; or the force will be completely defeated, and then the defeated animate matter will step into chemical compounds so strong and accurate that every smallest trace of organic composition be wiped out and destroyed, it will be unable to self-organize or will tear up organic compounds to allow for transition into chemical compounds; or, finally, the two forces will separate, so that each may remain faithful to its own activity.

76. — And since affinity works at the opposite ratio to the quiescent powers, and straightforward ratio to free heat

7 *Początki Chemii*, § 11.

flowing in entities,[8] so free heat helps activities related to affinities about to occur at the same ratio at which it weakens the quiescent powers. Mainly, it acts and against bonding as against quiescent affinities. Experience corroborates it entirely. The great property of matter of heat seems to be quite dependent upon its willingness to combine with all entities in general, and because organic powers work together against all affinities and cohesion, so the activity of caloric helps them in this respect. This is the primordial reason why heat is inevitable for life and growth of organic beings. Without it no assimilation, no organic process, and therefore no life would be possible.

77. — On the other hand, as much as caloric is in opposition to quiescent affinities, it fosters and helps *active* affinities, or those which are yet to present themselves. Therefore, as much it helps organic power in dissipating chemical compounds and in assimilating disorganized matter, so much in organized matter it supports and maintains chemical combinations which are yet to present themselves. And there is another reason why heat is indispensable for life. The matter which has already experienced *individual* forces, and therefore has either partly or completely ceased to be viable, is no longer subject to organic power (57), so it must return to the realm of affinities whose activity is contrary to organic powers which focused on organizing, so much that their work is to dissimilate and disorganize it. Because *individual* life

8 *Początki Chemii*, § 19.

depends on continuous organization of the newly arriving matter and proportionate decomposition of its own, (65), and because organization depends on organic powers, so decomposition, disorganization and, therefore, related activities and events must depend on affinities and heat that aid them.

78. — It is, therefore, necessary to assume two never ending processes in each living being — one *organic* and the other *chemical*. The newly arrived matter which, until final assimilation, continues to be a subject of organic processes, slowly liberates itself from chemical laws at the same ratio at which it experiences organic powers and impressions. Thus, organic processes are those in which organizational powers overwhelm and defeat; such as for example, digestion of food, its processing into blood, production of solids from blood, all secretions, etc. Nonetheless, when matter has gone through these processes, and begins to liberate from the organic power, the action of affinities must commence and be noticed. Thus, chemical processes will be those in which affinity wins. Such, primarily will be all *excretions* or *excrements*. But because more or less chemical powers can persist in organic processes, just as in chemical processes, organic powers or compounds formed by them can still partly remain as residue. This is why chemical products can retain more or less of the organic character and this is why they may differ considerably from completely dead matter.

79. — It is necessary to distinguish between organization itself, that is organic form, from organic *compound*

or *bonding*. Organic binding may be present in entities, although all traces of the organization will be obliterated. For example, vegetable extract, glue, sugar, jelly, egg white, etc., do not display any trace of organization, though their compound or bonding is organic. I understand bonding in natural entities as follows: *firstly*, between completely dead homogeneous particles of matter there can not be another force other than the one whose power matter is attracted towards itself. Attraction, therefore, bringing such particles together arranges itself, by the repellent power of caloric, to find a certain equilibrium dependent on density of entities and relative position of their particles. Such a *cohesion* depends on attraction and the repellent power of caloric is called *simple* or *physical* cohesion (*cohaesio simplex*), and so this is the cohesion all dead entities perceivable by our senses succumb to.

80. — *Secondly*, because even the smallest particles entering a physical relation of entities may be disassembled, just like entities themselves, into elements differing from each other and from the entities themselves, therefore, these particles must be considered to be chemical products — inherent matter's attempt by the power of which elements of different nature tend to combine and form a new variety of entities. Such a bond of matter is called a *chemical compound*. Thus, all chemically assembled entities will firstly be found in such a compound and, moreover, in a physical relationship. When affinities have been saturated, the smallest combined particles, being homogeneous with respect to

each other, will be found in the first described case (79) and, by the power of attraction and caloric, will be arranged into in a certain compound.

81. — *Finally*, in organic beings, where *individual* power acts both against chemical compounds and against physical bonding, while arranging natural elements of viable matter and bonding them in their own manner a new compound arises — different from the preceding one — which should, therefore, be called *organic*. Elements bound in this way and constituting entities different from chemical compounds, considered to be already free from further action of organizing forces, must be equally obedient to the powers of attraction and caloric and must arrange themselves in a certain physical union relative to these two forces. And so, all the organic beings, with respect to their finest particles, find themselves — just like all other matter — in a physical compound and, as to the assembling elements — in an organic compound. This is why it is easy to discern between an organic compound and an organic system. That is also why it is easy to conceive that Chemistry is neither able to create organic beings nor even inanimate entities which include organic compounds; and why animate entities are those in which such processes can occur. Regarding, therefore, the composition of entities in this respect, there are obviously two of its kinds, namely *chemical* and *organic composition*. So, *organic Chemistry*, as based in a different origin, should be entirely separate from *general Chemistry* as science.

82. — Turning our attention to heat, it follows that the weaker the influence of organic power on affinities within a genus, species, or *individual*, the more heat such a genus, species, or *individual* will need to sustain life, and vice versa. Due to the fact that every genus, species, or *individual* possesses particular organic power, it is no wonder that each requires their own characteristic temperature to sustain life and complete freshness; that almost every beast and every plant can live only in an appropriate climate. For the same reason, they require only so much heat as they may suffer as a result of its deprivation and it weakens their activities, likewise they suffer from abundance of heat. What exceeds the absolutely necessary intensity can not help organic power; will not proliferate organic processes; and will foster disorganization and all natural discharge. And so, the excess of heat helping only chemical processes will slowly dissimilate the organic entity, will exhaust it and destroy. The power of heat can intensify up to the greatest excess so, finally to dissolve organization and matter will obey the laws of chemistry.

83. — But if the excess of heat closed in some confined areas does not reach the highest degree and, in the meantime, nourishing matter arrives at the ratio of the increase of heat, then all organic and chemical processes, therefore life in general, will proliferate at the proportion of such increments. An example at hand is plants which grow faster and more abundant, showing more potency and freshness the more they have food and heat altogether. Lack of moisture

and strong heat, or too much nutrition in the cold weakens and destroys them equally.

84. — There are contradictions in plant life, and there is a certain balance between organic powers and affinities, therefore all the phenomena of growth of life and opulence of plants will depend on decent moderation of nutriment and heat. If these two conditions are adequately met, if light — an inseparable companion of stronger ambient heat — is strong enough, then digestion, feeding and growth of the plant will proceed superbly. If light and heat begin to prevail, the activity of organic powers will be significantly intensified; matter ingested will be best absorbed, water and carbonic acid will be perfectly broken down and, as a result, more oxygen will be emitted by the plants, more inflammatory substances, oils, resins, aromas will be produced, but significantly less floral acids and oxides. And to the contrary — with the scarcity of heat and light and abundance of water and carbonic acid, breaking down of these two compounds and assimilation will be far less accurate. Such plants will produce less oils, resin, aromas or none at all; they will fill with glue, carbonic acid and water. Therefore, humidity and shade is particularly favourable for all watery, gluey and acidic plants, such as fungi. This is why such plants will enjoy cold climates, low and humid areas. On the contrary, the plants by nature dry, resinous, oily, aromatic will prefer higher altitudes, dry areas exposed to strong sun and hot climates.

85. — And if the power of light and heat were unalterable, organic power would be the more assured, and the

less it would have to divide and weaken, it would have less matter to absorb. Now, keeping affinities in mind, the fewer affinities to overcome the said organic power will find, the stronger it ought to be. The fewer affinities it will find, the less foreign matter an organic being will absorb. So, assuming the same warmth, if the organic being feeds moderately within certain limits, the organic power within it will be more assured and vice versa.

86. — And because the organic forces and affinities work against each other and tend to eliminate each other, so *firstly*: the stronger the organic force, the less intensely affinities or chemical processes will present themselves. Let us assume that, generally, organic power is stronger in animals than in plants; and among the former it is stronger in those which feed on a larger number of organic beings, consequently, in the latter the fewest chemical compounds may occur, and their consistent matter, so to speak, has liberated itself from the power of affinities. *Secondly*: the fewer affinities an entity consisting of viable matter, or its constituent elements, will have with the elements of a given organic being, the easier it is digested and assimilated, and vice versa. The affinity may sometimes be so strong that it will liberate matter from the realms of organic power and, having torn the organic bonds, will partially or completely disentangle the animate being. *Thirdly*: whatever is able to weaken organic power in animate beings, will facilitate all chemical processes and be detrimental for organic ones; it will foster the emergence of affinities and disorganization; whatever

destroys it completely, will restore total power of affinities over viable matter. This return of the power of affinities will be more assured and fast, the more perfectly the organic force will be muffled, and the more liberated is matter from the power of affinity the weaker was the organizing power.

87. — In accordance with our original assumptions, it is clear that following complete cessation of the organic force, that is, after death, viable matter can not remain for long in organic compounds but sooner or later, suddenly or slowly must return under the power of affinities. As a result, old bonds should dissolve and other bonds should emerge. Such a state of dead organic entities is called spontaneous decomposition or fermentation (*fermentatio*). And thus, the entire chain of fermentation will be an uninterrupted decomposition of organic entities and a continuous sequence of chemical combinations, therefore, everything that aids affinity in general, will foster fermentation, everything that disturbs spontaneous combinations is capable of preventing fermentation or stopping that which has already begun.

88. — A necessary condition for affinities to present themselves in dead matter is the weakening of the bond, i.e., decent dilution of the fermenting mass which can only be accomplished by heat and dilution with water. Moreover, decent amount of moisture and heat will definitely be needed for every fermentation. Without them, a dead entity will retain its composition and form, or fermentation which has already begun will not be able to continue. For this reason,

those organic entities which by nature are dry and hard, such as trees and all plant fibres, animal bones, hair, horns, hooves, etc., may not break up for a long time. This is why even completely dry animal bodies, with little juice in them may stay intact under the ground in dry, cool and well-ventilated places, in sand or around limestone, though withered over long stretches of years. This is why we usually preserve meat by drying, or plants by burying them in dry sand. Salt, saltpetre, and so many other salts prevent meat from rotting by taking away moisture from the fibres which would otherwise dissolve in it, and constantly decreasing the temperature as a result of long and slow dissolution.

89. — A great part of compositions created during fermentation finish in combustion of elements which participate in organic composition. Such is abundant formation of carbonic acid, water and, in some cases, vinegar. For this reason, the entire fermentation can be considered to be a kind of slow combustion. This is why free access of air, and especially oxygen, is needed in the spontaneous decomposition of organic beings. And for the same reason, these beings — while covered by water up to a significant level, buried deep in the ground or submerged by acidic liquid, spirits or oil can not dissimilate and decompose. This random durability will be the longer and more assured the less the fluid itself is prone to decomposition, either as such or thanks to its influence on organisms immersed in it. This is the reason of exceptional applicability of spiritus vini in protection of animal organisms from decomposition.

90. — Now, as attraction ties and binds natural entities, giving them a certain regular arrangement and a certain strength of bond; as affinities also bind diverse particles in a certain way, in the same way organization gives matter a certain bond and certain composition which we have called organic (81). Although in the organized matter life may expire, and the organizing power ceases to operate, such a relationship, once having occurred, must continue as long as the other opposing forces do not dissolve it. Or rather the forces by the power of which the organic composition was formed persist and last in that matter, even dead, but asleep and saturated, and therefore inactive, that is, quiescent. Therefore, if affinities can not operate in dead organic beings, the organic composition must remain in place; and if slowly and only gradually, with the aid of heat and humidity, affinities begin to present themselves, composition will dissimilate only slowly and gradually. And because when it happens, spontaneous decomposition may be stopped at any time, before chemical products emerging from the decomposition can still retain some characteristics of organic compositions, and therefore may differ from other chemical combinations occurring in totally unorganised matter. In short, until organic compositions have not been completely destroyed in matter whose origin is in organic beings, this matter may not be considered to be a simple chemical product. Such complete flattening produces merely organic decomposition or final spontaneous decomposition.

91. — From the viewpoint of degrees and the difference of its products, three types of fermentation are recognized, namely, *vinous*, *acetic* and *putrid*. In the first type wine is obtained, the essential character of which is to supply spiritus vini by distillation. The second results in vinegar with which we are all familiar. The third, which is the final result of the first two, completes the organic decomposition, and converts everything into water, carbonic acid, and soil. Because during this last degree of fermentation in all animal substances and in certain plants ammonia is produced, it has been desired to consider the formation of this gas as its essential feature; which is absolutely true only for the entities which contain nitrogen in their organic composition.

92. — What is evident from these principles is what I said in other places[9] about fermentation. Namely, that dead organic beings all tend, though not all equally, to spontaneous decomposition. This difference is due to the fact that the elements which constitute them have been uniformly liberated from the power of affinity, therefore they return under its laws with unequal and relative rapidity and force. Those which have experienced with the greatest energy the organic power, i.e., those whose system has gone the furthest astray from the laws of affinity, will break down the fastest and return to the realm of chemistry. Those, on the contrary, whose structure still belongs in a very large part to the domain of affinity, or whose structure is less opposed to their

9 *Początki Chemii*, § 350.

natural order, will only disintegrate slowly and not rapidly. Moreover, with their constitutive elements remaining in a state of certain balance and their affinities being so greatly constrained, this equilibrium may often remain stable for a very long time, and spontaneous decomposition will not take place until the first impulse is received which, by tilting the balance, initiates the work of affinities. So these organic beings which tend most strongly to spontaneous decomposition, will rot away immediately. Others, whose arrangement is less opposed to affinities, will begin with acetous fermentation, yet others from vinous fermentation, passing on to acetic and putrid. So, in short, all the compounds — in other words — organic combinations operate against the natural order of affinity, and the more powerful and complicated these combinations are, the more violent will the tendency be to destroy them, on the other hand, the more favourable the circumstances are to affinities, the more rapid will be the ultimate dissolution of organic combinations.

93. — All the animal parts in general and, among plants those whose composition is more perfectly structured are dissimilated with extreme promptitude and strive straight to putrefaction. Vegetable mucilage and starch form first vinegar which, left on its own, passes to the putrid fermentation. Sugar and, naturally, all sweet plant juices, suitably diluted with water and exposed to necessary temperature, turn first into carbonic acid and wine which then turns into vinegar, which also ends up putrefying. And since this whole range of chemical transitions can only take place in suitable

humidity, heat, and free access to atmospheric air, if at any phase of the said transitions one or all of these conditions are removed, fermentation will be suspended when such a change occurs and its further progress will be prevented. It will be in our power, by controlling conditions inevitable for fermentation, arrest it at our pleasure and thus to modify its products in every instant of its duration. In this respect not science, but experience has long been a useful guide.

94. — Fermentation, considered in this way (and it can not be otherwise), will only occur in dead organic beings, where organic combination exists, and in which life and all its functions have been entirely extinguished. In animate being, where organizing power acts constantly and predominates, where organic combinations proceed without interruption, nothing similar to fermentation can occur. Where affinity more or less is active, activity between affinity and organizing power is divided and is an average product of these two powers. In some cases, postulated putrefaction in organized being during their lifetime definitely can not take place, unless it is local, if life in that specific part has completely expired. Admittedly, though, in certain circumstances, in which the organic force is weakened, and hardly sufficient to prevent the total extinction of life, the anti-organic forces must assume a proportional ascendancy, and tend towards the complete ruin of the machinery. However, in all diseases, in all cases and under all circumstances it takes place in the period preceding death, therefore, it is not limited to any particular case.

95. — We can not, therefore, dam up the anti-organic power in living beings, except by intensifying its sole antagonist, namely the organic power, and by supporting organic processes, as in dead organic matter putrefaction can only be prevented by removing the conditions essential for fermentation. In medical science, the knowledge about medications supposedly having the power to resist putrefaction can not be supported by pure reason. And to suppose the possible putrefaction in the living machine, is to admit the existence of wine in the grape still holding on to the vine.

CHAPTER V

BURIAL OF VIABLE MATTER IN THE BOWELS OF THE GLOBE. ITS RETURN TO THE EARTH'S SURFACE.

96. — Because viable matter, once having organized itself, can not dissimilate completely without heat, water and air, even after expiration of the organic power, so whenever it finds itself in such condition, it will not be used as food by other animate beings or processed, then it can retain its structure intact for a long succession of centuries. In antiquity, powerful men, whose most favourite element was vanity, unable to transmit the best portion of themselves to posterity, strived to leave at least their corpses incorruptible. Finally, their heirs, having washed the bodies, after removing or putrefying their entrails, sprinkled them with soda and kept in it for several dozen days; then washed and dried the corpses and massaged with perfumed oils and balsams. These gave protection against access of air and water, and themselves, slowly attracting oxygen, changed into a kind of veneer, even stronger defending the corpses against water and air. All these bodies thus prepared were strongly wrapped in a thin, gummed cloth. Then, thin clothed canvas

were wrapped around them. Some remains of this industry of Egyptian antiquity have even reached the present day.

97. — Nature, which in its great work brings forth the greatest results, often hides and buries in the bowels of the globe masses of organic beings or their corpses, and thus conceals them for centuries. Due to the fact that the whole outer layer covering the globe owes its origin almost entirely to organic beings, and consists almost entirely of their half-processed corpses, the entrails of the earth also present to us, at a great depth, with an infinite number of such broken and shapeless beings. The seas, which cover the greater part of our planet, nourish in their bosom an innumerable multitude of organic beings, which every day terminate their existence — united, mingled by the waves, and amalgamated. Rains, spills, flooding, all proceeding to the common channels of the rivers and to the bed of the seas, there also carrying a considerable quantity of organic fragments. Let us add, also, that these same waters carry the strips of river beds and fragments of mountains, imperceptibly raising the bottom of the seas, whilst the soil thus falls proportionately by these losses. Hence it follows that the seas after the centuries have elapsed, are forced to abandon their habitat and gradually inundate some new portions of the earth's surface. The deeper the water in the places once flooded, the deeper buried in the ground the remains of organic beings. To this daily and insensible work of the waters, we must add sudden and enormous revolutions, which our globe appears to have repeatedly wiped several times. These sudden revolutions

include extensive floods or deluges, earthquakes, vortices, or violent shocks of the atmosphere, which often fell entire forests, etc.

98. — Such organic compositions whether they lie at the bottom of the seas, or by violent earthquakes transferred to the bowels of the globe are incapable of experiencing a natural and spontaneous decomposition. Both the temperature in the places where they settle is too low[10] and the access of air is improbable. Water, with which they may be covered, and some mineral bodies, are the only substances which have an immediate effect upon them. The water first dissolves and carries away all the sugary, gummy, salty, and extractive parts; then slowly softens fibrous parts, works them over, crumbles and dissolves; thus plant and animal parts slowly transform into oils, resins, sulphur, and grease, over which water has no power. Such final resinous and fatty elements of dissimilated organic beings taken over by the mineral kingdom, augment its empire, mingle and combine with inert matter; or else accumulate in the rocky masses of the bottom only to reappear here and there with the waters on the surface. This is the unmistakable origin of fossil coal and all of the fats of the terrestrial globe. Chemical analysis proves that these mineral substances are in no way different from the oils and resins, and that they consequently come from a common source. This water induced decomposition, together with resins and oils, produces a considerable

10 The temperature is stable at + 10° *Réaumur* scale [+ 12.5° Celsius].

quantity of sulphur; it is therefore not surprising to find so great an abundance of pyrites in all deposits of fossil coal.

99. — These historical monuments of organic beings in the fossil kingdom are so abundant in our times that, except for the very core of the globe which seems to be formed entirely of granite, the earth itself seems to be made completely of layers, more or less rich in organic remains, an obvious effect of activity of water. The fossil coal alone surpasses all other fatty substances of nature, and there is scarcely a country where its layers would not present in many areas at a certain depth. Such is the abundance of fatty and inflammatory bodies, hidden between the layers of earth, and particularly pyrites, which are abundant in such deposits, sometimes igniting. Water seeps and gathers between the deposits, and this is why it must ultimately be dissimilated by the pyrites. This is how oxygen passes into the sulphuric compound, producing a considerable quantity of caloric, which, though slowly, heats up the whole mass of deposits. The heat, once in play, accelerates still more the decomposition of water, already begun, and becomes itself all the more intense. These transitions follow each other step by step imperceptibly until, finally, these immense stores of combustible substances are brought to such high temperatures that all adjacent waters are either dissimilated or changed into aqueous vapour. If, then, a communication is established between them and the sea, lakes or large rivers, the waters warm up and decomposition or transformation into aqueous vapour increases. Then, the enormous quantity

of hydrogen and aqueous vapour, finding no subterranean cavities, no cracks, no caverns sufficiently spacious for its indescribable, unrestricted, barely understood expansion, circulates and moves in all directions with an indescribable, unlimited and almost inconceivable force. It breaks, overturns and destroys the obstacles that would have seemed invincible. Subterranean bowels of the earth are violently moved; its trembling surface experiences convulsive and repeated shaking. Struggling and striving in proportion to the efforts of resistance, finally it breaks everything until it opens a free exit to the exterior. Atmospheric air having once access in these vast masses of inflammable and burning matter, kindles the earthly bowels which begin to burn. The release of gases and vapours increases with the fire; The earth trembles again, often embracing large areas, entire provinces, and entire kingdoms until these lofty bodies have themselves found an exit, an opening to the surface. There, gathering and transporting all that could still afford them some obstacles, they throw an abundance of inflamed matter, ash, water, earth, rocks, molten or half-burnt bodies into the air with violence and crash. These first efforts of the aqueous vapour and of the hydrogen at their exit give birth to earthquakes; their outcome is that of volcanoes.

100. — It is sufficient, therefore, for an earthquake to take place that water, which moistens pyritic layers or deposits of mineral coal rich in pyrite, has dissimilated in part and given rise to hydrogen: volcanoes, need to have access to external air. Since there are few regions which do

not possess in their bowels beds of pyrites and fossil coal, so earthquakes may occur everywhere, and volcanoes have existed around the whole surface of the terrestrial globe or may appear in the future. Every part of the globe has its volcanoes, not to mention the extinguished ones whose traces can be found in nearly every country. Earthquakes can only occur when the gaseous bodies, formed underground, have no free exit to the exterior. It is for this reason that they exist, either far away from volcanoes and promise their eruption at any time, or in their vicinity of volcanoes, when, by some fortuitous circumstance, communication is interrupted between their hearth and the volcanic crater. In the latter case they anticipate the eruption and cumulate in a volcanic eruption. This theory explains, in the most precise manner, all the phenomena of volcanoes, though here I can not engage in an extensive enlightenment of that subject.

101. — This is the way by which the organic remains, accumulated in the mineral kingdom, are dissimilated and consumed by fire. The last result of this conflagration is to transform all these substances into water, acids, carbonic acid, sulphuric acid which escape from the crater in gaseous form, and ash being thrown away by volcanic eruptions. These elements of viable matter, buried in the bowels of the globe, reappear on its surface, where they transform into new organic beings and again may initiate life. It is thus that immense stores of viable matter, which nature had held back for centuries, captivated in its abysses, and which seemed to have been lost forever, now have the possibility of

returning to organization and life, and the means employed by nature in order to attain this sublime and impressive end are volcanoes. From this we see how great is their utility in the universal composition of the terrestrial globe, and how important their functions are in maintaining the general equilibrium. We see, that if they sometimes destroy a very small quantity of living beings, all benefits from it in common. Finally, we see how marvellously the supreme Author of all things ties the string of effects and causes. Without the presence of organic beings on earth volcanoes, which must have appeared very late after the creation of the world, would never have existed. Without the volcanoes, this enormous quantity of viable matter, accumulated every day in the depths of the globe, and having no means of returning to the surface, would have been lost forever for organization and for life. These losses being daily repeated, and without ever being repaired or rewarded, the number of organic beings would diminish at the same proportion, and eventually would perish and disappear.

102. — *Water* is the most essential agent employed by nature in order to attain such great results. Water is the most powerful element ruling all organic beings; it is this which is the most general cause of their transport and their long residence under the strata of the earth, it is the instrument of their decomposition and of their change into greasy compounds. Water, therefore, gives rise to creation of layers of fossil coal and pyrites and, finally, instigates their decomposition, shaking the globe and originating volcanic eruptions.

Thus, the same cause which, for a long period of time, has closed the path of organization and life, brings it back only to bury it again. So, in this case, just as in the entire system of nature, the causes and effects converge and are mutually connected.

CHAPTER VI

MORE PARTICULAR CONSIDERATIONS ON THE LIFE OF PLANTS. DETERMINATION OF THE ORGANIC POWERS THAT ACT UPON THEM.

103. — In every kind of life, in each of its functions and organic parts and, finally, in the entire organized nature, there is a perpetual struggle between organizing and anti-organic powers. The former includes organic power and viability — their mutual union constitutes *individual* organization and life, the latter physical cohesion and affinities. And because, in the plant kingdom, physical cohesion of beings serving as alimentary substances is practically nil, it can be concluded with certainty that only affinities resist organic powers. It follows from this that all the viable matter entering the substance of plants introduces two forces in them, that is to say, two causes of action and change, which are: *viability*, with a tendency to deprive organized matter of its form and life, and the power of *affinity*. It tells us that external bodies acting on plants, do so by viability and affinities.

104. — This action belongs entirely to the alien unorganised matter, introduced into plants, and is exerted entirely

on matter already organized. And due to the fact that an organizing being is not able to exert power onto the former save for organic or assimilative power, and these two kinds of powers are opposed to each other, it follows that every introduction of matter into plants establishes at this moment a spontaneous *action* and *counteraction*; the former endeavouring to deprive organized matter of its present structure, and to subject it to the empire of affinities, the latter tending to organize the matter still unorganised. From this action and counteraction arise the phenomena of the life of plants or of *vegetation*, which must depend, in part, on affinities, viability and organization, or rather on these three powers at once. And as we give the name of life to the union of these phenomena, we shall also recognize that the causes, that is to say, the forces which constitute the life of vegetables, are *viability*, *organizing powers*, and *affinities*.

105. — If we come to consider matter as acting only by the power of viability, that is to say, by its tendency to organization and life, we shall see each effort of this tendency followed by a reaction of the corresponding organic power to assimilate a portion of the unorganised matter, and proportionately process a part of the organic matter. If we consider it as acting by affinities, each exertion of these powers must subdue part of the organic powers and, consequently, submit a greater or less portion of the organized matter to the chemical laws. And vice versa, each organic function must in some measure destroy affinities, and drag a part of the obedient matter to organic structures. Organic power is

directly opposed to affinities and acts against them, while viability, affording them mutual assistance, helps both the organic force to process the matter introduced into the organic structure, and affinities to dissimilate matter already provided with organic structure.

106. — Thus, the more powerfully matter introduced in the plant will act by affinities, the more the organic power will be oppressed and the more matter will be subjected to chemical powers and, consequently, the closer such a being will approach its decomposition and the end of its existence. Those beings, in which affinities are already saturated, exerting the least power on organized matter, will subject it the least decomposition by chemical powers, and lessen the organic force. But on the other hand, the more saturated the affinities, the forces necessary to dissimilate them, to subject them to organic ties, and to assimilate such beings, will have to be greater; And, as heat and light are the two most energetic powers against quiescent affinities, it follows that organizing beings will most need heat and light. This is the major cause why vegetables, which live only on water and carbonic acid, can neither be sustained nor grow without heat, light and water. Decomposition of carbonic acid is difficult, therefore, quiescent affinities between elements which constitute them are very strong.

107. — In plants, therefore, in general, there can be no organic activity, no assimilation, and no excretions (*excretio*) without heat and light. Vegetation, indeed, like all other organic beings, produces by itself large quantities of

internal heat; but this production is due to their vital force, to organic functions, and also depends on external caloric. Speaking of the heat, we always touch upon the idea of light because the specific manner in which the latter operates and behaves, is little known to us, and that these two have a common source of influence, namely the *sun*. The sun is, therefore, in the most rigorous sense, one of the essential and indisputable causes of plant life, one of the forces which constitute it. Without it, the viable matter placed on the surface of the earth could neither organize nor live. This is evidently proved by the state of *vegetation* in the cold seasons, the almost eternal winter of the polar regions. This is why the sublime Creator of all things chained to the sun the earth which he covered with viable beings, and forced the terrestrial globe to turn around the sun. The other planets were undoubtedly the objects of the same providence.

108. — Because vegetables feed only on water and carbonic acid, and these two constitutes their origin; and, assisted by heat and light, they exhale an abundant quantities of oxygen, therefore, it is necessary, in assimilating these two natural substances to destroy not only the quiescent affinities existing between the elements which constitute them but, looking from the viewpoint of chemical relations, they also greatly diminish the amounts of oxygen. Therefore, in this respect, *vegetation* must be considered as a partial *decombustion* of water and carbonic acid. So, each plant and each of its parts must be more or less combustible. Experiment confirms this truth in the most satisfactory manner possible,

and the chemical analysis of vegetables teaches us that they all should be considered a sort of oxides (*oxyda*) with a double base. But, apart from oxygen, which plants exhale in light, they still exude large amounts of vaporised water and, in the shadow, also carbonic acid. Their natural excretions are therefore reduced to water and carbonic acid. Thus, their assimilative powers process water and carbonic acid into their own substance, while their dissipative or chemical force dissimilate them and transform them back into water and carbonic acid at the same proportion. The first of these processes predominates in light, the second in the shadow. The principles which we have set forth above (78) illuminate and perfectly confirm this theory. But as the vegetable-organic process expels a great quantity of oxygen, it is necessary that this loss be replaced, so that the chemical processes can in turn convert the vegetable body into water and carbonic acid. This is the reason why plants can not live long enough without the free access of oxygen.

109. — All that precedes us leads us to the following corollaries: *firstly*, plants require the access to oxygen in order to be able to keep their excretions in a proper manner, that is to say, in order that they should not experience any interruption in their chemical function. *Secondly*, the organic function of plants being a *decombustion* of water and carbonic acid, and their chemical function being a true *combustion* of hydrogen and carbon; this process, according to the general laws of all *combustion*, can not be effected without oxygen. *Thirdly*, the common opinion introduced into physics that

plants purify atmospheric air is erroneous, since it is evident from our lecture that, on the one hand, they improve air, on the other that they deteriorate it. *Fourthly*, on all their surfaces, but more particularly at all points, where water and carbonic acid are formed, plants experience a slow, perpetual and insensible combustion, and where assimilation takes place, their nutrients approach the state of combustion. That is to say, that they *combust* incessantly on the one hand, and *de-combust* on the other. *Finally*, without regard to the solid parts of plants all their fluids have more density than water, and consequently much more than carbonic acid, therefore, the organic force, assimilating these elements, renders them more dense and more fixed. Whence it results that, in each part of a plant where assimilation takes place, a proportional quantity of caloric must also be released, thanks to which plants heat themselves perpetually in the course of constant organic process. But, in view of the fact that the organic process is never interrupted, and thus the development of caloric is continuous, plants would warm each moment more, if the formation of the aqueous vapour and the hydrogen gas by the chemical process had not absorbed and carried off this excess of heat. In a word, as much as the organic process heats the plants, so much the chemical process cools them down at each moment.[11] Now, these two opposing actions

11 It appears that heating and cooling down in organic beings takes place in a manner contrary to that which occurs in dead beings where burning heats nearly always.

being constantly exerted throughout the course of plant life, it is not surprising that plants always possess a temperature peculiar to themselves, and which depends much less on the thermometric state of the atmosphere than on that of their individual life. If the external heat is excessive, the chemical process (82) is proportionally multiplied and reduces the plant temperature below the atmospheric. If the atmospheric temperature is too low, then the intensity of chemical process diminishes with it, and the plant thus losing less caloric, heats up thanks to the organic process and will exult its internal warmth. All this can only take place to certain limits beyond which the heat pushed because excess heat always weakens the plant more and more until it is completely destroyed; similarly, intense cold entirely suspends the organic processes, and may ends by extinguishing life.

110. — If, for whatever reason, the organic power was too weak or remained deprived of its usual auxiliaries, in such a case ordinary food could not be properly digested or assimilated, but would remain more or less in a state of crudity. Hence, it is not surprising that plants left without the benefit of light, have an assimilation always more or less imperfect, and that they are infiltrated with water, carbonic acid, and mucilage. Vegetable assimilation being, in the chemical sense, a continual *decombustion*, therefore the more advanced *decombustion* will be, the better seconded by the presence of heat and light, the fuller plant parts in the course of formation will become. Thus, oils, aromas and resins must be the latest creation of plant assimilation, while

mucilage and acid must be the primarily. But these first productions, gradually traversing the series of organs, and successively experiencing a more energetic assimilation, may in the end themselves assume all the characteristics of these latter plant products. This assertion is confirmed to us in the most striking manner by the daily observation of the vegetation itself. All the plants and all parts thereof are, in their beginnings, aqueous, mucilaginous, and acetous. Later, mucilage and acid are processed into starch, sugar, and vegetable fibre and, at the latest stage, into oils, resins and aromas. Thus the same constitutive materials of the plant proceed in succession, and by degrees of assimilation in other parts.

III. — By chance, some substances may be introduced into plants, the quiescent affinities of which are so powerful, that the plant-organic power may not be able to dissimilate them, such entities can not be assimilated. Nonetheless attracting a portion of this power, diminishing it and weakening it in organized matter, they will favour disorganization, chemical functions, and all excretions in general. The plant thus losing a considerable quantity of matter, irreparable by the entity which causes this damage, must be exhausted, weakened, and finally perish. Experiments, upon which it is impossible to raise any doubt, have convinced us that mercury and other metallic or saline bodies, artificially introduced into plants, have led, more or less quickly, to consumption and ruin. Certain exhalations, gases or vaporous, are likewise evidently harmful to them. These effects will be all the more powerful and rapid, as the deleterious bodies will, by themselves or by their constitutive elements, have a greater affinity with those of organized matter; an affinity by means of which those bodies will even succeed in triumphing over the organic union, destroying ant tearing it completely. In this case, if such powers act with energy or in a prolonged manner, they may eventually completely extinguish the organic power and dissimilate the organized being, partly — if the influence is limited to some of its parts or completely if it is extended throughout the plant machinery.

CHAPTER VII

SIMILAR CONSIDERATIONS ON ANIMAL LIFE.

112. — Air and water are for the life of animals, as well as that of plants, of an absolute necessity, and the aid of caloric is no less indispensable for their assimilation. However, most of them produces a considerable degree of heat in their own organisms; by this very fact they demand less imperiously the influence of the sun. But having regard to this consideration, that all the heat of our planet has its source in the solar irradiation; The life of plants and animals must depend on this influence, but less evidently in animals. We are therefore forced to consider caloric in them as one of the first causes of life.

113. — Plants, by destroying the chemical combination of the elements which constitute water and carbonic acid, assimilate particularly hydrogen and carbon and, with the help of the solar rays, dispose of the greater portion of oxygen.[12] The animals, by virtue of their organization, appear

12 As it seems unquestionable that the matter of light belongs to the composition of oxygen, and that this gas can not be formed without it, therefore it is possible that light may be necessary for vegetation only for the purpose of formation of this gas so that decomposition will not cease to continue. In the same way in which hydrogen is necessary for the formation of carbonic acid.

to dissimilate and produce water equally, but whether they assimilate hydrogen only, or the two elements at once is hard to tell. A question all the more difficult to solve as we do not know in what manner and by what means they would dispose of oxygen. It is to be hoped, however, that experiments undertaken some day for this purpose will shed more light on these matters.

114. — As the nourishment of animals and that of plants differ so much, their relation to organic power, their mode of elaboration and their assimilation must differ equally. Plants do not directly take in organic beings, water and carbonic acid suffice for them, but animals support their existence with organic beings as food. Because the affinities between constituting elements of those are largely destroyed, and the chemical combinations metamorphosed into organic bonds, it follows that assimilative forces have much less the chemical forces, but much more organic powers to beat. The organization of an animal is such that all the preparatory processes of digestion are destined to annihilate nearly all the organic texture of food. It is only then that assimilation itself breaks the organic bonds in the alimentary body, and gives the elements of viable matter a new form, as well as different structure.

115. — The forces of life, that is to say, those which constitute plant life, are: on the part of assimilated matter, viability and affinities, and on the part of the living *individual* the organic power. The influence of caloric and light, or solar influences, must also be added to them (104–107). Among

these different powers, organic power and affinities fighting directly must finally attain a sort of equilibrium, influencing the union of plant matter and, in particular, special local forms of organisms. We can therefore assume as that in all plant matter, which has not yet entirely lost its organic union, these two kinds of forces must persist in part and balance one another. The animal organic power, playing a role in assimilating such matter, should destroy and to distort completely the mode of existence of the pre-existing union, and so, partly exert against the last remnants of chemical forces, and partly against plant organic forces. This new power, acting against the two others, destroys them and transforms their work more or less, but always ends by placing them in a new equilibrium. From this point of view, the union which takes place in plant matter may be considered as *organically-chemical*; similarly, that which occurs in animal matter, ought to be considered as the result of common concurrence, and of a certain balance of animal and *vegeto-chemical* forces. And as in plant parts, affinities are not all equally destroyed, animals that feed on plants will also have, sometimes more or less, affinities to overcome. On the other hand, adjusting themselves in a balance with *vegeto-chemical* forces, they will destroy and extinguish only their part, so chemical forces must be preserved, at least in part, even in animals, far stronger, in those who feed on plants, and infinitely less so in those who make their nourishment of the animal substances. Now, if we consider the entire mass of organic beings, we will see that chemical forces have their place everywhere, but to very different degrees in their different areas; so that there may be certain organic beings, plants for example, where they are subdued or transformed, while in other organic beings, for instance in some animals, they can scarcely be counted for anything. In other words, organic powers which are exerting and struggling against affinities throughout the living world, alter and perpetually change the chemical products of the viable matter, in this manner gradually liberating it from the reign of affinities which is freed in proportion to the progress of organic transformation.

116. — This remark also applies to vegetative-organic powers. The plant compounds are destroyed only in part, by the animal-organic powers, and placed in equilibrium with them, therefore it should be assumed that the latter must persist and be preserved in animals, at least in part and for some time. Or rather, the elaboration and organic union of the viable elements which has taken place in a plant is not destroyed, but only reworked and perfected by the animal which makes it its nourishment. Hence it follows, that the matter of this animal may change in its combinations, having regard to the nature of the aliments of which it makes use. This is testified to us by the daily experience of domestic and wild animals, whose form, habits, taste, tenderness, flavour, vary according to the difference of the substances on which they feed. The choice of food, then, can not, in any case, be indifferent to us. And it is not without reason that great legislators have not hesitated to give their nations

precepts on the kind of life and the nature of the food which they were to make use of.

117. — Animals and plants differ, or more or less closely approximate, in form, composition, and organic union. Hence it follows, that the more the structure and organic transformation of any being becomes analogous to that of a second being, to which it is to serve as food, the easier also it will be for the first assimilate the second. Having regard to the mere ease of change, the thing can not be otherwise. Thus it may be assumed that in animals *the promptitude and facility of assimilation and replacement of organic matter is in direct proportion to the approximation of the form which it is to take*. But, on the other hand, the more matter has traversed the path towards organic formation, the more it has lost its viable character in its relations with the great organic whole (57). It follows, therefore, that *the ease and rapidity of assimilation of organic matter will also be at direct ratio to the loss of its relative viability.*[13] Each introduction of viable matter, corresponding to a loss of the same matter, and each assimilation corresponds to a proportional dissimilation (65); the organic dissimilation, and all the excretions which depend on them, *will be equal in* all circumstances to the *inverse ratio of the viability of matter introduced in the organism*. The matter that will have lost the most of its viability, will therefore be the most likely to maintain and increase all excretions in the animal economy, while the most viable

13 This law will be limited below.

matter will produce contrary results. Thus, the greater the similarity of the bond of beings which we feed on to ours or, what amounts to the same thing, the greater the loss of viability of organic matter, which we have absorbed as food, the easier and more rapidly we can digest it, convert it into blood, and assimilate it to ourselves: but also, in the same ratio, we will dissimilate and lose our own matter by various excretions. Animals which feed on the flesh of other beings analogous to themselves, are thus more easily renewed than those which live on plants. Or, what amounts to the same thing, the viable matter circulates more rapidly through animals feeding on meat than on plants.

118. — Now, since *individual* physical life consists in continuous organization of the newly introduced viable matter and a corresponding and proportional disorganization of organized matter (65), life must therefore be directly related to these two. Speed of life is much more rapid in animals which feed on flesh than in those which have only plants for food. To express this law more clearly, and to generalize it for all living beings, we shall say: *the rapidity of the vital circle of each organic being is in inverse ratio to the viability of the organic matter which serves it as food*.

119. — What, then, are the forces of life in animals? Evidently be the same as those of plant life, adding, nevertheless, the organic power peculiar to them. That is to say, the vitality of matter will exist in both animals and plants, but will be much higher in animals, and characterized by the particular force of each species. Having, *firstly*, regard to

air and water — substances which are indispensable to sustaining animal life, and which offer only their affinities to combat, considering also that some of the affinities are still preserved in the plant and animal matter on which animals feed, consequently, affinity is one of the forces operating in animals. *Secondly*, both plant and animal parts have a union which is peculiar to them, and which they carry with them into the animal body, the *individual* force of which must transform it. It must struggle against formative forces, a struggle which will cease only to the restoration of the balance between assimilating and assimilated matter. We must also consider these forces as active causes or one of the powers of life. Caloric is also an absolute necessity for all living creation. Animal life is therefore more complicated than that of plants, and more so because it consumes a greater quantity of organic species for its maintenance.

120. — We have already said that animals producing a degree of heat themselves are much less dependent than plants on the influence of external temperature. We shall examine elsewhere in what manner they produce it, and to what extent they depend on the ambient temperature. We also know (76–77) that every living *individual* requires, for assimilation as well as excretion, a degree of heat indispensable to aid its organic and chemical functions. These functions, as we have said above, can not be stopped even for a very limited time, without the irremediable extinction of life. It follows, then, that the total suspension of *calorification process* (*prosessus calorificus*), however brief, must

terminate instantly and for ever *individual* existence. But if the calorification process does not cease irremediably but slows down to a certain degree, assimilation, and all excretions must diminish at the same ratio. And if, in this case, the quantity of food and drink does not diminish but is increased still further, then the animal body will swell with matter only half-assimilated and weakly endowed with animal characteristics. This circumstance leads to obesity, a state which will occupy us elsewhere in a more extended and more particular manner.

121. — If, on the other hand, the calorification process becomes too energetic, assimilation and animal excretions will be greatly exalted and eventually predominate (82). When it becomes excessive, it will more and more exhaust the living being, and drag it to its consummation and ruin. Thus, just as obesity denotes too intensive calorification, so emaciation, all things being equal, announces an excess of energy. The state of life in animals, therefore, depends at all times on maintaining the process of calorification and on its intensity.

122. — Since animal assimilation is bound to change and transform the mode of previous bonds of organic matter, it may happen that a chemical or organic compound of the introduced being's substance may have a considerable degree of force, and be so strong that assimilative powers it will not be able to process it. Such a substance, therefore, can not be fully assimilated but, by diverting a portion of the organic forces upon itself, must weaken other organic processes by so doing, and thereby may become dangerous to animal economy. Since animals feed on plants or other animals, it is either from one or the other that they can experience resistance. In all cases, either this harmful body will not allow to be assimilated and remains only until it is expelled from the system or, developing a power opposed to the assimilative forces, will dissimilate and disorganize a greater or lesser portion of matter, or finally, destroying the organic force in the living individual, will thereby suspend the organic processes, and thus annihilate life. We shall henceforth designate all the bodies of this kind as *harmful organic forces or powers* (*potentiae nocentes organicae*), because they are essentially pernicious to animal economy.

123. — If these plant powers are too weak to be able to dissimilate animal matter, and confine themselves to resisting all the efforts of assimilation, so long as they are not expelled from the organism they will produce no other harm other than to unnecessarily draw upon them a part of the assimilative forces, and thereby weaken more or less the organic functions. But if the matter which constitutes them preserves all the organic powers specific to itself, in this case this force will not only act by opposing animal assimilation, but may sometimes prevail over it and, consequently, diminish, suspend, or even annihilate it altogether. Such powers will thus be capable of weakening and even totally suppressing the organic functions, and will become real *poisons* (*venena*) for animals in which they will produce similar effects. But although the common action of all these poisons

is confined to attacking and debilitating organic force more or less, and by virtue of which they effect these injurious results, being peculiar to each of them; it follows that the mode of poisoning and the phenomena which they manifest will also fade in each of their species. Independently of this, the organic compounds in plants still depend to a great extent on affinities. It may happen that the latter find the means of showing themselves between the elements of animate plant animal matter in a sufficiently energetic way to openly attack and destroy the organic bonds. Thus plant poisons may be of such nature that they weaken organic powers, and diminish all organic processes to their complete annihilation. Or those rather less powerful against organic force limit themselves to destroying its exertion, that is to say, dissolving the bond of animal matter, or, finally, both actions at once will be found in this matter merged to a certain point.

124. — All such poisons which attack the organic force with or without success or more or less triumph over the organization, if they are not energetic enough to completely overcome the assimilative force and thus annihilate the course of life, they must finally be rejected by the organism or assimilated. It is for this reason that poisons of this kind, even the most formidable, if they have been at first weakened, dilated with water, or introduced at very small doses into the stomach, though attacking and altering the organic power quite violently, will no longer be poisons. In a word, it is only in certain respects and in certain determined circumstances that they will be able to develop poisonous results. Indeed,

it is this class of natural plant substances to which we are indebted for almost all our effective medicines, and the most active poison in one case becomes in the second the most efficient remedy.

125. — Animal matter may not only resist any kind of assimilation and produce the harmful effects which we have already mentioned, but there may exist some which, being capable of preserving the organic force with which it is made, act reciprocally with respect to the organizing force and attack. Such matter does not merely oppose the assimilative force, but aspires to overcome the *individual* power, and thus dissimilate more or less matter and change to a being mirroring its own image. If this pernicious action extends above all the *individual* system, it can destroy both organic power and, consequently *individual* life. If this foreign substance limits its assimilative power to a certain place, it will revive and proliferate there, destroying the part of the body over which it exercises its empire, turning this part into itself.

126. — Such an action of the harmful matter, influencing organized portions, takes place in a living body; This attacked portion will oppose that action, and it is in proportion to this resistance that it succeeds in annihilating the pernicious part of the assimilative force, and in decomposing the other foreign part. Hence it follows, evidently, that the more energy the *individual* strength has, the less the introduced foreign matter will have the means of regenerating by its assimilative virtue, and the more effectively organic force overcomes it, the less it leaves it to invade its own

domain and vice versa. If, on the contrary, *individual* power resistance is too weak, matter will multiply, spread rapidly and, finally, end by dissimilating the animal machine. Such is the actions of all the animal *infections*, known under the particular name of *contagia*.

127. — There is, therefore, a reciprocal struggle between the assimilative power of the contagion and the organic power, in which one of the two must inevitably prevail. If the organic force succumbs, it brings with it the loss of *individual* existence. If, on the contrary, it emerges victorious from this struggle with the contagious power, it suspends its subsequent progress of assimilation of its own matter and shall assimilate the contagion, or eliminate it from its own system. Once it has succeeded in gaining the upper hand, it will successfully resist all the successive efforts of the contagion, and protect forever its own matter from its assimilative power. It is not surprising, therefore, that contagious diseases, which can exert assimilative power on living systems, can usually instigate disease in the same *individual* only once, and close for themselves a path to future activity. We will deal with it elsewhere in a much more extensive manner.

128. — But since all genera and species possess organic power peculiar to themselves, and each *individual*, each of its organs, possesses one which is peculiar to it, and which is but a portion of shared *individual* power, so *firstly*: poisons, venoms, and contagions only affect certain genera and certain animal species. *Secondly*, there may be animal poisons, venoms, and contagions which may be assimilated and

defeated by all the organs of a given *individual*, or at least are incapable of producing appreciably harmful assimilative effects in it, with the exception of one or some, where they can overcome the organic power, show their pernicious energy and, if they are provided with assimilative power, will regenerate and multiply. This assertion is truly the result of daily experience. there are, indeed, poisons, which, with impunity introduced into the stomach, present no obstacle to digestion, while introduced by any other way into the organism, provided only that they can avoid the power of the stomach, will attack and destroy the whole machine. Such, for example, is the venom of the viper; Such is also the venom causing rabies, which though enters in terrible combat with the entire organic power, can only regenerate in the salivary glands alone.

129. — Thus poisons, or plant venoms, compared with animal venoms, act in a completely different manner. This arises principally from the fact that the former can not assimilate animal matter and, consequently, regenerate itself in it. Nevertheless, both have, in respect of their harmful influence, a notable analogy, which consists in that: *firstly*, their joint action is deleterious to the organic power and to the organization. *Secondly*, in view of the different nature of the animals and their organs, poisons are either innocent and easily assimilated, or produce the most fatal results. From all these considerations, we draw the following conclusions:

Firstly, the inorganic bodies, and those which possess no organic bonds, effect both plants and animals by purely chemical forces; henceforth we shall give them the name of *harmful chemical powers* (*potentiae nocentes chemicae*). This class embraces all mineral and metallic substances, all their oxides, salts, acids, earths, alkalis, etc. In a word, all those inanimate substances which have no trace of any organic compound in them.

Secondly, plant and animal substances which still retain, in whole or in part, their organic structure or combination, such as parts broken or only extracted from plants and animals — carved or mashed, their juices, *infusions*, *decoctions*, *extracts*, *dyes*, *oils*, *resins*, *gums*, *starch*, *gelatine*, *albumen*, etc., never behave as merely chemicals, but always in a mixed, *chemical-organic* (*potentiae chemico-organicae*) manner, or attacking the organic powers themselves, may act in such a way that, in some cases chemical activity will be so energetic that their organic action will be almost inappreciable, in other cases their chemical activity being almost non-existent, only their organic activity will be revealed. Finally, these two activities may show themselves as equal or nearly equal.

CHAPTER VIII

REGENERATION OF ORGANIC BEINGS.

130. — The organic power, once it has been imparted to matter at the time of primordial creation of the living world, can not be destroyed by any natural cause. The duration of created beings and of life is therefore assured forever. However, in order to provide for it in a certain way, the creative power must act without interruption, or that which amounts to the same thing, the first creation must continue and organize perpetually, otherwise life would cease as well as self-organization of beings. We have already perceived this great truth in *individuals*, in whom the organization carries on restlessly, and is maintained by the constant influx of an ever-new matter; so the essence of their existence consists in perpetual replacement of the matter which constitutes them. The genera and species which compose the whole living sphere also have their origin in the primordial creation of the animate world and certitude of preservation and duration. This certitude must be founded on continual maintenance of the organic power in genera and species; but this power, which has given them existence and which keeps them during their life, owes its persistence only to its perpetual activity. Now, as genres and species comprise of

individuals, similarly, *individuals* — of viable matter, they can be preserved only by the continual formation of new *individuals*, and the others sustain themselves only by the constant organization of a new matter. Thus, as much as *individual* existence depends on a continual replacement of matter, the generic existence is subordinate to successive renewal of *individuals*, one putting them in the necessity of a constant relation between them and viable matter, the other linking them to the species of which they are a part. An *individual* impulse is receive to form the first bond, the second is driven by generic force, acts there for the common profit of the species, and by the accomplishment of this double aim, the shared interest of the entire creation is satisfied. The existence of the whole organic creation would therefore cease entirely if *individuals* ceased to renew themselves, and they would also end if they were to discontinue the replacement of viable matter, so life is an inevitable succession of perpetual change.

131. — We may call replacement of matter in organised *individuals* by the name of *regeneration* (*regeneratio*) the replacement of *individuals* in their genus and in their species will be *regeneration* (*reproductio*, *regeneratio*). The necessity of both evidently results from the very nature of the organic power which, exerting itself, must be in perpetual motion and activity. From the same cause stemming from the very nature of organic power also followed the necessity of *individuals*, their fall and regeneration, since it is by this means alone that life can be explained and maintained in matter.

In a word, the general existence of the whole creation, being connected with regeneration, is also connected with the fall of *individuals*, and must constantly steer towards this aim. *Individual* interest is therefore, in this respect, is in opposition to the general interest. Thus, in order to assure the duration of organic beings by regeneration of *individuals*, and to incite the *individuals* themselves, it was absolutely necessary to attach them to genera and species, and if I may so express it, divide them into two. Nature had attained this great end by forming the sexes, and by thus giving to each isolated creature a double existence, that is, *individual* and generic.

132. — But just as *individual* life depends on perpetual exertion of organic power on new matter; so life of species must depend on the successive formation of new *individuals*. The tendency to renew itself perpetually and to provide matter proper to this end is a purely *individual* tendency. And since each *individual* is contained in its genus, it really possesses a double life, half *individual* and half generic. Thus divided, all living beings must live at the same time in a double manner. It is for this reason that the act of reproduction can not be fulfilled by a unisex individual, and is not a personal, but a generic function.

133. — As we have seen above (28), as many times as a new *individual* begins, as many the organic power has to precede — if only for a moment — the origin of this new life; and thus a beginning of an living entity is nothing more but the commencement of an *individual* organic

power: the generic process resulting from a unity of sexes must, therefore, depend on the creation of a new *individual* force which will animate a new being and initiate a separate being. Because this creation is produced by the two sexes contained in the same species, the newly created force must also to belong to this species. But how is the instigation of this new force done? It is equally impossible to conceive and to determine as it is to understand what the organic power itself is, what its origin is and its mode of operation. This is why not only this organic process, but all, as to the manner in which they take place, must remain for us an impenetrable mystery.

134. — But as animals can not feed on dissimilated viable matter, they assimilate only that which has already been organised, i.e., matter from plants or animals. The assimilation of this matter is the easier for them, the closer its organic bond is to their own, just as every matter to be assimilated must first be decently prepared; in the same way, *individual* force can not be kindled without distinction in all matter, but only in that which has been procured by previous work. For this reason, the organs of generation appear to be destined for the preparation and preservation of this matter, in which the combined action of the two sexes are to kindle new organic power. The entity, thus disposed to reproduction, is the egg, peculiar to the generic parts of the female gender. The majority of physiologists attribute the power to instigate *individual* force in the egg, or fertilisation, to male fertilisation seed.

135. — It is nonetheless certain that this generic function takes place only in one way in all living creation, that is to say, by the contact of the fertilisation seed of the male with the egg, but the means by which nature manages this contact are infinitely varied.

In plants, deprived of voluntary movement, and especially of the faculty of locomotion, the same *individual* most commonly comprises both sexes at once, which is called *hermaphroditism*, that is to say, a circumstance in which the separation of the two sexes is not complete. In animals, on the contrary, this division is perfect, and each of them forms a distinct *individual*.

136. — In genera, in which sexes are completely separated, one *individual* does not embrace the entire generic force; it is easy to see why reproduction can be a purely *individual* function. But on what does this function entailed in a union between the sexes depend? How does it initiate life of a new *individual*? For general reasons. which we have already stated, understanding the phenomena of creation is beyond our power. However, it seems appropriate in this context to focus on the following considerations. The organic power which is to determine the form and life of the new being must be the shared result of the concurrence of both parents, because neither of the *individuals* of any sex possesses in itself the whole of the generic force, can not conquer it, nor completely fulfil the generic function on its own. It thus appears that the egg contains only the matter capable of shaping the first structure, which will then be elaborated

into a new *individual* whose organic power initiates at the very moment of the generic function, that is, at the instant of the union of two sexes. Clearly, the egg contains only the first food of the new individual, if we can use the term in this case, and the force which must produce it beforehand and give it its structure, which — in a word — is supposed to begin its life, is not active until the time of the generic function common to the two *individuals*.

137. — From this principle, that each kind of assimilation requires proper matter, and prepared in advance for this purpose, it is easy to conceive why it is only in the egg that the new *individual* may be initiated. Due to the fact that it is the common result of the assimilative force of both parents, why must it be of this species, and not of another? Why is resemblance of the two preserved? Why, if two individuals of the same genus, but belonging to two different species is it a blend of both?, etc.

138. — On the basis of the same principles it will be easy to conceive why generic coitus can not take place between animals of different genera; the organic powers of two different genera, which are opposed to one another — one must react against the other, destroying their action reciprocally, therefore, the egg has no organic power. But even if such a coitus did take place, producing new organic power, and would give rise to a monstrosity hitherto unknown, than such monstrosity could not live due to the imperfection of its organism or, finally, might be alive and fully formed, but finding itself isolated in creation, deprived of tribe and

species, it would have only an *individual* life, unable to fulfil any generic functions, unable to regenerate any further. Thus, nothing contrary to the fundamental and eternal laws of nature can endure. And since observation confirms that such deviations of nature never occur, and that if they present themselves, they can not perpetuate or reproduce themselves; we ought to, therefore, recognise the immutability of the established order and the truth of a doctrine which, based on the permanence of the creative force, can not suppose any aberration contrary to the primordial organisation of nature.

139. — If we resort to experience, we shall see that it is in the fluids, through them or in them, assimilation in animals take place. It is them where assimilative force resides hidden. Thus, the alimentary digestion is effected by the aid of the gastric juice; their later elaboration is due to bile and to the pancreatic and intestinal juices. The blood gradually assimilates the chyle, and then changes it into itself, and finally change into other juices in whole or in part. Experience teaches us also, that such an assimilative force subsists and preserves itself for a long time in these fluids, and even beyond the limits of the living organism which produced it. Nature seems to have followed this path in fertilisation, by giving the egg the organic power, through the fossilising seed, which is also a fluid. Speaking of the fertilising seed, all physiologists attribute this power only to that of the male, since there is doubt of the existence of a female seed, and it is not even known what might be the

secretory organs. If, therefore, the origin of a new *individual* is effected in the same way as any other organic assimilation, all this work should also be attributed to the fossilising seed, which at the moment of coitus reaches the egg and remains there. Thus the egg is fertilized only when it is in contact with the male seed, admitting its part in its interior. This seed, capable of acting on a suitably prepared matter, and possessing a necessary degree of viability must, if the other requirements are met, produce an action and be in equilibrium with the forces proper to it. Thus begins the life of the new *individual*.

140. — If it is, indeed so, then fertilisation of the egg and the beginning of a new *individual* in this egg itself does not, therefore, depend, as was generally supposed, on the awakening of a being already formed, but on the intromission of a fluid capable of fertilising matter in the egg, and the establishment by this very process of a new force which, under favourable circumstances, begins to act, to organise and to create a new *individual*. Everyday experience can convince us that everything happens in this way. In the unfertilised egg nothing has been seen but a particular fluid, yet nothing resembling an organic being which is to emerge in the future. True, the same matter enclosed in the egg becomes imperceptibly converted into a new fetus. Where life has once begun its course, it can no longer cease to act even for a moment. For fear of complete extinction, but in fertilized eggs life can often be preserved for a long time, obscure, in which form the egg can be transported from one

pole of the globe to the other, which teaches us only that the fertilizing seed, admitted into the egg, may remain there inactive for a certain length of time until other necessary circumstances have materialized to excite its activity. But once these conditions are fulfilled and the course of *individual* life begins, it can no longer be suspended without the loss of the *individual* itself.

141. — It follows from the principles above that, in whichever particle of organic matter the entire generic force is found, it can reproduce and regenerate its species and vice versa. Such is the cause why hermaphrodite *individuals* are self-sufficient in the reproductive work, and can regenerate their own species. This is also the case with plants which multiply by their buds and branches over unlimited length of time. The observation of this kind of regeneration, the simplest and most evident of all, can furnish us with the best idea of this beautiful act of nature. Let us stop and consider it for a moment.

142. — Most common and everyday experience tells us that a branch separated from its trunk, stuck into the ground, or inserted in another stem far from ceases to live — it grows, becomes a tree similar to that from which it has been extracted, and now lives a separate life. The branches of the latter may, by the same process, vegetate in isolation and, in their turn, become as many new trees the branches of which can offer the same results. The tree, which has furnished the first, will neither lose its life nor its subsequent growth; a cutting taken from it becomes a

trunk, which may thus give birth to new branches and give rise to new *individuals*. Thus, the species can multiply and reproduce indefinitely by the same means. But due to the fact that the life of every *individual* is limited, the mother stem, provided equal circumstances, must perish first, and after it, successively and without exception, all others in the order of their birth. Thus, on the one hand, *individuals* arise and multiply, and on the other, fall and perish.

143. — But as the first cutting belongs, in a rigorous sense, to the trunk from which it originates, and is really a part of it, the tree which comes from it, and all those who are born of it, will, if I may so express it, be considered as parts of the prolongation, and finally a continuation of the first stem. Therefore, all the successively begotten *individuals* will be a creation an extension of the original one. In this sense, all proliferating *individuals* of any genus were enclosed in their original parents, and by regeneration they develop and grow. The generic organic power is regenerated successively from one portion of matter to another, and thus assures by this uninterrupted transmission the duration of the existence of its species.

144. — If, then, in the multiplication of trees which we have taken as an example, it is from a single *individual* that a series of generations has its origin, it would be absolutely necessary to admit that all this lineage owes its existence to the extension and development of this first cutting, therefore, that this single trunk contained all the *individual* members of this family, as they themselves contain all their

successors.[14] Furthermore, the generic force has from the creation always been the same, lasts until now and will continue forever. Each species may therefore be considered to be a whole, as a single *individual* divided by multiplication into more or less isolated parts.

145. — The regeneration and multiplication of plants by a seed, and that of animals by an egg, are perfectly analogous to that of which we have just spoken. In both cases a part isolates itself from the living organic being, a part entirely invested with an *individual* force capable of deploying under favourable circumstances, and which devotes itself to activities of viable powers peculiar to itself and prepared for it. In perfect animals, this organic power is entirely in no other part than in the fertilized egg; in some plants it exists only in the seed, and these plants have no other means of reproduction and regeneration of their species. However, in the greater number of plants, besides the seeds, this force is found in the fruit, and in the buds, which by their later development may produce branches, leaves, flowers, seeds and, by

14 Physiologists understood such a placement of all *individuals* of a given species in the original parents; they supposed that it was in the egg that the first, unformed and shapeless entity was residing, though asleep. For it to awaken, male fertilizing seed was needed. And because this entity supposedly enclosed in miniature all parts of which it was to consist, so if this entity was of a female genus, she enclosed not only eggs from which her children were to hatch, but in those eggs, in the same order, were enclosed other entities, and inside then — eggs, and so it continued along an infinite series.

the same token, in branches which end everywhere in buds. The reason of this difference between animals and plants is a much more complicated organisation of the former, and of an almost uniform simplicity in the others. Indeed, the consistence of the organic tissue of the branch is so analogous to that of the stem that it is distinguished only by age, just as in animals the age alone differentiates the progeny and parents.

146. — We regard as an isolated *individual* a portion of organised matter which can be immediately vivified by external bodies. Thus, in the first example, the branch, as long as it belonged to its stem, drew its nourishing substance from it and could only be considered as a part of the tree itself. Fruits and seeds are, similarly, part of the plant which they belong to, and owe their nourishment and development. The same is true of eggs, when they are inside the animal which carries them and from which they derive their origin. But as soon as they have been fertilized and have reached a certain degree of maturity, they are in a position to receive the external stimuli themselves. From that moment they separate, if I may so express myself, from their common stalks, and begin a life and an *individual* existence. But since *individual* life (65) consists in a constant organisation of matter newly introduced and in proportional disorganisation of own matter; since vivifying matter is itself viable and is transformed into the being that feeds on it (52); this capacity of the egg and the seed to receive external stimuli is therefore nothing but the capacity of assimilating and organising viable matter. Thus, fertilisation of the seed or egg is nothing but

bestowing such a capability; all organic beings are renewed, regenerated, and multiplied by the formation of parts in which there is an assimilative force analogous to the species, and which can thereby be entirely separated from the entities who gave them birth, assimilate and live independently from them.

CHAPTER IX

COURSE OF LIFE OF ORGANIC BEINGS, THEIR GROWTH, MATURITY, DECLINE AND FALL.

147. — We already know that organic beings in general can not exist or be formed except by viable elements, and that by this very fact they are subject to certain conditions, which limit both regeneration and multitude. Viable matter is chained in organic bonds, or it is completely disorganised and subject to physical and chemical laws. In the latter case the greater part, which can not be consumed by animals, would be lost to them forever if the plants had not had the power of digesting it and changing it into their own substance. From this we concluded that plants are an indispensable condition for the existence and maintenance of animals and, consequently, for the maintenance of life in the viable matter in general. Applying plants to animal sustenance, it may be said that plants prepare, modify, and elaborate viable matter for animals, so that organisation and assimilation, as they take place in animals, has already been commenced by plants, in the plants it continues, is perfected, and completed. Plants, then, are, in the general system of

living nature, connected with animals in the sense that they prepare the materials necessary for the sustenance of their being and their lives. Relative to the viable matter, they are the door of the organisation and the first stage of the scale of elaboration that this matter must traverse in the organic life.

148. — There are plants which can only feed at the expense of other plants, even of certain kinds; likewise, there are animals which feed only on animals, not on plants; there are others who can not live on plants; it must therefore necessarily be concluded that there are animals which elaborate and prepare plant matter for them, and that their existence is one an absolute condition of existence of the former. If, then, there are plants which live and exist only at the expense of other plants, if there are animals which live only on plants, other only on animals, and yet other on both, we must recognise that in the whole system of living nature there is a perpetual progression of organisation of the same matter, a series of its successive changes; that its existence under each of the forms is purely transitory, but that these forms themselves are permanent and lasting only because new matter constantly replaces the preceding one and takes its structure; therefore, *life in viable matter, in general is a perpetual change of forms, and in a given form, and a perpetual replacement and change of matter.*

149. — The whole living portion of our globe, therefore, may be considered as an *organic oneness*, of which the genera and species are the different members, but so interconnected, that some are indispensable for the existence of

others; that they help and serve each other; some prepare food for others' sustenance and pour their life into them, so to speak, like a river. Thus, life of the latter is but a continuation and perfection of the former. And, finally, viable matter, by traversing successively all these different levels, circulating from metamorphosis to metamorphosis, produces the phenomena of general life. From this point of view, the formation of an organic being is only a passage, a prelude to the formation of another, and life of the great whole will not only be a continual function, but also a perpetual transition from some parts to other parts.

150. — In this universal and constant circulation of the viable matter, the formation of the organic members is connected by a determined and regular order. The existence of any successor necessarily presupposes that of a predecessor, and, so step by step, to the primarily: so if all the organic beings were to be completely destroyed and had to begin life again, they would have to reappear in this world in a certain order: beginning with the first of this immense chain, and advancing in formation from those to the last ones. Then, matter would have to return to the state of *shapelessness*, and then resume the universal organisation if its members. Such is the constitution of the organised world in general. [15]

15 These remarks bring our first conjecture (71) closer to the truth, namely that the organic power is the same in different genera and species. If there is a continuous progress of organization in the entire animate world of nature, and some parts are elaborated and processed into next

151. — What takes place in the immense machine of the living world is repeated with as much order, and obeys the same laws in the isolated beings which compose it. It is then that these various phenomena strike our senses more strongly and astonish us much more, because our feeble intelligence is more likely to grasp the details than to embrace the harmony of the whole universe. Each plant, animal, man, all begin with a lean particle of matter, with a drop of liquid, and with merely an atom. The course of life, once sketched, follows its regular course, always elaborating, working and perpetually improving new juices and organs, until it finally reaches the last line of its perfection and of its growth. Then, no longer able to extend itself in its own sphere, it insensibly returns to its origin, and endeavours to resume the imperceptible and atomic form which it has originated.

152. — In the fertilized egg, which does not contain any preformed organic apparatus, only suitably elaborated and prepared matter, *individual* force is inserted into matter, firstly free heat is first necessary to excite and to maintain the first acts of this force. Once this awakening has been given, the course of life begins, and from then on the matter contained in the egg is elaborated. Once elaborated, a new matter must constantly flow, so that the movement of permutation which constitutes the *individual* life does not stop for a moment. The formation of the different fluids, parts

parts, the force elaborating the final ones must be stronger than the initial force which could not have advanced such elaboration any further.

and organs, is manifested in a regular succession, proceeding in an orderly manner, and in this fine sequence each organic function lends its aid to that which follows it, and thus prepares and introduces the subsequent action. The matter elaborated in an organ and imbued with this first life is transmitted to another, which elaborates it in its own way and sends it further in its turn. This succession takes place until, finally, the viable matter has lost all its viability for the system which contains it and is expelled beyond its periphery. *Individual* life is, therefore for matter. like general life — a continual change of form, and for the *individual* a continual replacement of matter. In such an order of things all parts can neither form at the same time, nor attain equal degree of perfection at the same time; but they must, so to speak, both slowly and imperceptibly form gradually, one from the other being, let me put it this way, their first beginning. Every progress of organisation changes its relations with the surrounding world, and thus the phenomena and relations of life also change. Thus, a certain degree of external caloric is indispensable to the new being, so long as the organs intended to produce it or to extract it will not be formed and put into action. The influx of the external matter will not be necessary for this purpose until the matter that contained in the egg has not been completely elaborated; Later, the type of accessing viable matter must be modified according to the nature and force of the organism, and thus successively.

153. — But as in this admirable series, there is a first and almost imperceptible term, the general basis of all

subsequent growth, there must also be, by an invariable and universal law of nature, a culminating term, a last degree which can not be crossed, and in which the growth and improvement of the organism must be maintained. It was at this period that each of the parts, each organ, and consequently the whole machine, have reached the limits of their size and perfection. Once arrived at this insurmountable barrier, they can not grow and attain yet higher realms of perfection, they must therefore remain stationary for centuries, or else begin to fall. To remain in this state is impossible, since the causes of life and of growth do not cease to act, and continue to maintain the organic functions. The latter, being unable to perfect themselves or to grow further are thus forced to decline, to gradually weaken, and finally to die out.

154. — Each *individual* life therefore has two terminals, one the *lowest* (*minimum*) and the other the *highest* (*maximum*) of its existence. This last state may be called the *midday of life*, which, once passed must gradually lower according to the same order according to which it grew, slowly marching up to the very end of its course. But as the moment when the sun is at the zenith is extremely short, as it occupies only an indivisible moment, it is therefore possible to divide the whole course of life into two portions: one destined growth and perfection of the organism, the other for its decline, its destruction, and the insensible approach of its ruin. Life, to speak more briefly and more expressively, is therefore composed of two periods: that of organisation and that of progressive disorganisation. However, having

demonstrated above that all organic processes, from exertion of organising powers and their predominance over the counter-organic powers; just as the disorganising processes depend on the pre-eminence of affinities; It is clear that in the first half the organic powers prevail and give direction to all life, in the same manner in the second they slowly weaken, and by this means give more and more access to affinities until they succumb to their power and by arresting all the organic functions, and thus also life. Such is the natural course of the course of each particular life and its natural end, too often accelerated by violent and foreign causes.

155. — Because organic processes predominate until the noon of life, and from that moment they weaken in an insensible manner, and yield to the counter-organic powers, we must imagine *individual* life as a constant and uninterrupted series of changes, combinations, and elaboration in the viable matter, dependent upon the reciprocal reaction of the organic and counter-organic powers; the former prevailing at first, and finally weakening entirely at the end. The latter, to the contrary, are the strongest at the end, and the weakest at the very beginning. Or, rather, we may consider that from the first kindling of the *individual* force, counter organic powers acting perpetually on matter in which the individual force has been kindled, and tending to destroy it and extinguish it there: while this force reacts contrary to them, and constantly maintaining its equilibrium. It maintains itself until a certain period, insensibly extends over an increasing mass of matter, but weakens on account of this

extension, yields as a result to the counter-organic powers: The latter becoming more energetic in their turn, oppress it every moment more until the total extinction of life.

156. — Hence it follows that organic power is all the more active because it is exerted on a smaller quantity of matter. That is, *this force acts in inverse ratio to the mass of matter.* One of the most luminous laws to which we can attain in the physical sciences — it demonstrates the essential difference between the organising powers and the counter-organic powers (attraction and affinities), which act in direct proportion to the masses. Individual force can not, therefore, prevail over the physical force proper to matter in general, except by limiting and, if we may so express it, condensing it in the smallest possible mass of matter. It is also to such a density condition, that is to say, to this condensation of the organic power in the smallest portion of matter that the birth of the new *individual* is due. Thus, the intensity of this power and the degree of its limitation must determine the course and duration of life, and must restrict the limits of extension of organic development.

157. — And since the energy and the action of the organising force follow in each period of *individual* life the variations of the mass of matter submitted to it, and the different intensity of the counter-organic powers, it is not surprising that the organisation and consequently the form of *individuals* experience perpetual variations throughout the course of life. And that every *individual* is quite different in childhood, maturity, old age, and decrepitude; indeed, it

is still changed in each of its periods, and that there are not two instants when it is similar to itself.

158. — Such is the inseparable character of the first half of life: by reason of the predominance of force, of all organic processes will intensify, and organisation will extend and perfect according to the same relations. In the second period of life, on the contrary, the counter-organic powers gradually prevail; the organism must regenerate and dissimilate more and more. We begin, then, in the natural order, to die from the moment when our growth is complete and our organisation carried to the last degree of perfection. And just as every moment of our duration is, until our meridian, each moment of our durability is a real profit, and progress, and since that time every moment is a loss, a true step towards death. Since the course of life is composed of these two grand halves, and the duration of the latter corresponds perfectly to the extent of the first, it follows that organic beings will generally have a longevity all the greater, as this first part has itself been of greater extent, that is to say, that their growth and perfection will have been slower. This truth is confirmed by the experience of all ages.

159. — This varied duration of formation and of growth may be considered among the various genera and species, or only between *individuals* of the same species. In the first case, this difference, which refers to the diversity of genera and species, must have the same cause, that is to say, it depends on the special nature of the organic power imparted during the first creation of all beings. It can not, therefore,

be the object of any inquiry. In *individuals* of the same genus this distinction is very slight; and it is infinitely probable that, first of all, the organic power of each particular kind may vary in some degree, within the species. Secondly, should it be equal in the same species it would be in immediate dependence upon external viable powers, the growth and the whole organic structure would also depend on these powers, and on a more or less rapid course of life. In this latter case, the development and growth of a given *individual* will be accelerated all the more rapidly, the faster comes the zenith of life, the organic fall and death all the more prompt as the powers will act in a more active way. Among these powers, caloric holds the first rank by its energy, maintaining at the same degree the organic processes as well as the chemical processes, therefore possessing the strongest influence on the status of life; this is why must attribute the great influence of climate, season, and atmospheric temperature upon the growth of organic beings. So, we can see that the more warm and serene the spring and summer are, the more rapidly the plants grow, ripen and yield their fruits: the more cold they are, and the later the appearance of these natural phenomena. The inhabitants of hot countries grow and mature more rapidly than those of cold countries; women are earlier ready for childbirth, men come to maturity faster and are earlier fertile. In the absence of natural heat, artificial warmth may also replace it and, to a certain point, produce the same results. That is why we see that in the most northern climates even, the children kept warmly, well fed, physicality active, partaking in strong meats, wines, warming beverages, spices, etc., are promptly brought to maturity and to the zenith of their lives, In contrast, even in the hottest countries, the children physicality inactive, poorly nourished and often going hungry reach the term of maturity only at later age.

160. — Since the whole growth is a true organic process, thus essentially favoured by heat, it follows that if there is abundance of caloric and, united to a proportionate degree, of heat, there is abundance of viable matter suitable for elaboration, growth will be rapid and correct; but if at a high amounts of caloric, whether natural or artificial, the scarcity of viable matter is joined, then the excess caloric will only promote disorganisation. The organic power no longer being able to expand or to exercise itself on a sufficient matter will be forced to restrict itself to a smaller mass. Henceforth, also the increase of these beings will be sensibly limited but, at the same time, the organic power will have the more energy.

CHAPTER X

EXAMINATION OF THE EXTERNAL POWERS WHICH MAY ACT UPON THE ANIMAL ECONOMY. ASSESSMENT OF THEIR RELATIONSHIP AND BALANCE.

161. — We have established from the beginning of this lecture (35–36) that the perfect knowledge of the life-giving and viable powers, and the just evaluation of their relations with organised beings under all circumstances is the only way to enable us, with some certainty, to have any influence on *individual* life. Since the most important aim of science is to recognise and appreciate all the accidents and dangers which threaten the human existence at all times in order to identify the ways of protecting ourselves when they only threaten us, and to build defences when they are already present, we are going to pay particular attention to this order of inquiry.

162. — We have learned in the course of this science that food and drink, and in general all substances which enter into the organic bodies by the way which is proper to them, exercise a certain power on living beings their particular force, which tends to dissimilate such a being, to deprive the

organised matter of its present form, and to bring it back under the laws inorganic beings (66). But if this matter is at the same time viable, it exerts power proportionate to the energy which makes it tend towards organisation and, in this way, it obeys the laws of *individual* force and effectively involves a part of it. The *non-viable* matter can not manifest such a tendency and must, consequently, oppose all efforts of the organic powers. It is therefore important for us to consider and study the matter introduced into the living body from the point of view of its *viable* and *non-viable* character. The characteristic of the former is that it can not by itself be clothed in the of the organic structure. Such is water, such are also atmospheric air, and any matter originating from organic compounds, or consisting of viable elements. But as all matter is viable in the same degree (55), let us examine, first of all, the laws of the increase and diminution of viability, and by the changes of ratio of this matter to organic beings. And *firstly.*

163. — Taking into account the totality of living beings, because, as we established in principle (62) *the viability of organic matter which is to serve as food will be in reverse relation to the advancement of organisation*: it is clear, *first of all*, that matter totally dissimilated and no longer retaining any trace of life or any organic cohesion, must be equally viable for all organic beings. Thus, water, carbonic acid and gases, hydrogen, oxygen, etc., will be equally viable for the generality of beings. The atmosphere, the sea, the lakes, and the rivers are inexhaustible stores of such matter, constituting

therefore real elements of all living creation. Such general elements, rid of all organic compounds, and very feebly subject to physical forces, can oppose to the assimilative powers of living beings only in one way, that is by *chemical* cohesion, that is to say, by the power of the affinities which are peculiar to each of them. Thus, whenever these substances are introduced into the living organism, their own tendency to organise, and the efforts of *individual* power for their assimilation, will have to fight only active and quiescent affinities. The ease of assimilation of these substances will, therefore, be at the inverse ratio to these affinities. *Secondly:*

164. — Since in the universality of living nature there is a progressive organisation of the same type of matter (148), the whole organic part of the globe must be considered as one organised entity (149) — a continuous and unbroken chain — whose different members successively transmit their own lives into one another. Thus, starting from the first links of this great chain, and in traversing it until the last, the viability of matter must also diminish in direct proportion to the progress it has made in the organism, and to exalt itself in direct proportion. Thus, the matter which enters the composition of the first links must be more or less viable for the followers, and relative to their respective positions, though is not so for the predecessors. Thus we see the plants, which form the first links of this great chain, serving as food for animals who can not feed on other animals themselves. If, then, in the whole series of living beings, these first links are the simplest and least elaborate, so to speak, and

the followers become ever more complex, then matter of the former must be more viable compared to the predecessors. Thus, we admit in principle the following order of things: *the organised matter, or matter which retains the cohesion proper to the organism, is doubtless the more viable the less perfect is its elaboration, that is to say, less advanced.*

165. — This elaboration varies not only in the different genera and in the different species of the animate and visible beings, but also in the different parts of the same *individual*, each of which has its own particular structure, and is imperceptibly transformed into other parts. And vice versa, there are some organic parts, which, though in very different genera and species, may nevertheless be almost entirely similar, or whose degree of elaboration is nearly identical, for instance plant mucilage, starch, oil, sugar, albumen, gelatine, etc., are always the same, from whatever source they come from. Such elements, characterised by very similar elaboration, notwithstanding the variety of the sources from which they have been derived, must also possess a somewhat similar viability. Hence, many organic beings may be equally viable for a given animate being, as the different parts of the same *individual* may themselves possess very unequal degrees of viability.

166. — This is not the case with isolated beings whose relative classification in the series of living beings also determines the relative viability of the organic matter which acts on them. In fact, in the same proportion as the organising elements lose their viable character relative to the form

they acquire, they must gain the more relative matter to other similar forms (67), so the more advanced they are in the elaboration of organic structure the more they will rid of their viable character with respect to all forms lower in classification, the more viable character they will gain with respect to the followers. Thus, for each isolated being, organic matter will be less viable, the further it will have exceeded the degree of organization which characterizes this being, and its viable character will be all the stronger, as in this progressive elaboration, it will be brought closer. Any animate being can, therefore, be considered as limited by these two kinds of matter — in one, the viable elements approximate to the degree of elaboration proper to the being itself, and its viability increases relatively to this approximation. In the second, the elements of viable matter have already exceeded this degree and the distance from it is ever bigger, they are not viable any more, and its non-viability is in direct proportion to more or less distance.

167. — Thus, each living being (165) is composed of many parts whose organic elaboration is so different that some have already reached their highest point of perfection and are only capable of being disorganized and secreted; while others, recently introduced into the system, or else slightly modified, constitute a raw material, which may be the object of all successive preparations. This virgin and raw matter ought, with respect to all others, to be the most viable, since it must replace them all; as well as that which has already exhausted all forms of replacement, must present the least

possible viability. Between these two extreme points there are a great number of intermediaries, embracing all particular progress of organization and of diminishing viability. Or, rather, all the points taken together mark only the progress of the movement which constitutes *individual* life, or the path traversed by the viable matter in life. It begins at its entrance into the living body and ends at its exit. In view of the fact that matter loses its viability because of its elaboration, we can express by this property any progression of this motion, and to say that the more a given matter is advanced in its organic mutations, the closer it is to the term of its *individual* course, and the less it is viable for that individual himself: one can consider each of these phrases as equivalent.

168. — Every living being thus possesses in itself a quantity of matter suitable for being elaborate and maintain its organic functions; new influx of foreign substance will not be only when this storage begins, so to speak, to be exhausted, when the most viable will have been for the most part elaborated, and that the organs which have been busy with this first elaboration will require new material for their activity. Hence, all other circumstances, the vital movement or the circulation of the viable matter in any *individual* proceeds with force and rapidity, and more frequent and more abundant must be the influx of the matter which serves it as alimentary matter. In the beings in which the course of life is slower, either by the natural order of things, or delayed by other accidental or habitual causes, the less must also be repeated and copious the supply of alimentary matter.

169. — Upon this foundation, each living machine in particular may be considered as possessing a certain degree of viable character of its own; just as each of its organs and each of its solid or fluid parts possess that same power, but at certain determined and different degrees. From this point of view, the more any organism contains fresh matter, raw and not yet elaborated, the more viable character it has. The opposite is also true, i.e. the less viability there is in the organism, the stronger must have been the exertion of the organic power. Each exertion of organic power destroys and extinguishes part of the viability; each influx of new matter more or less repairs this loss. But as this alimentary matter, introduced into animate being, offers different degrees of viability relative to it; it is clear that the greater will have been its loss, that is to say, the more energetic the action of the organic forces, and, moreover, if we wish to maintain the equation in the animate being. If, therefore, a given being receives no such viable matter, or receives only non-viable, due to the continual loss of viability such a being will approach its last dissolution, and this in the ratio equivalent to the exertion of organic power. In a word, in case of such a being, the less access to viability it has, the narrower the limits of organic functions will be.

170. — Food and beverages, therefore, restore this viability which diminishes and at every moment due to the course of life. But since each individual must have its degree of viability within certain limits, and each of its parts, too; it is also necessary that the matter entering such a being

should possess only a certain degree of viability within limits also given. Thus, each being is assigned the kind of food and drink, the kind of matter capable of maintaining its life, and therefore designed conditions which determine maintaining proper course of its life, determine its place in the great chain of living beings, and his relations not only with them, but also with the viable matter in general. Designed conditions which determine maintaining proper course of its life, determine its place in the great chain of living beings, and his relations not only with them, but also with the viable matter in general.

171. — If we consider that every *individual* living being, in order to live and organise, must remain under continual influence of vivifying substances, so that the food and drink is essential to the maintenance of existence in animals, the animals can ensure this effect only by exciting and maintaining the functions of which their lives are composed; if we recall then that *individual* life consists in the proportional organisation and decomposition of the viable matter (65), and that thus, with regard to food and drink, it consists in assimilation, elaboration and gradually organic improvement of the elements which constitute them while, on the other hand, there is separation and excretion of those which, *individually*, have ceased to be viable or, more briefly speaking, that the whole life consists only in elaboration and assimilation of the viable matter, in separation, and the expulsion of that which has ceased to be viable. Finally, these two kinds of activities which can take place only in organised

beings and, in relation to them is the course of life, while in relation to the beings beholding the *manifestation* (*manifestatio vitae*) of its phenomena, we may, without fear of error, give the name of *stimulants* (*stimuli*, *incitamenta*) to all entities which, by their influence on living beings, stimulate and provoke this manifestation of life.

172. — All natural organisms which find their way into animals in any form whatsoever can, *firstly*: can not be completely idle, deprived of influence, not showing any sign of life, because the organising power force exerts itself on every matter within the realm of its activity, and because for the constant exercise of this force, life is a continual strand of replacement and activity, and every activity is a sign of life. For this reason, it can be said that all sensations to which living beings may be exposed are for them a stimulating cause, that is to say, that each such impression must correspond to a sign of life. *Secondly*, since life is marked by two kinds of actions, that is to say, by organic *elaboration* and *decomposition;* the stimulating entities will excite one or the other of these activities, or both, at the same time. Let us examine them in this aspect.

173. — Bodies which are completely or in an *individual* manner non-viable, can not be the object of assimilation and organic elaboration, and are consequently not capable of exciting those types of activities. But as soon as they are introduced into the organised being, they will be able to excite activities not only on the part of animate which non-animate matter generally excites, namely an attempt of the

organism to reject it beyond its limits. Therefore, the entire excitation on the part of such entities will be to identify the processes, by means of which the non-viable matter is separated and expelled from the system. In a word, they will exhaust the animate being by the different excretions, without repairing the damage in any way. Organic power having no effect on these entities, can not, therefore, communicate to them the course of life. All the while, as they introduce with them the physical and chemical powers, which are entirely opposed to the organic powers, are capable of acting strongly against them, they may thereby weaken, overwhelm, or even entirely suspend all the organic processes; especially if the reaction of the system fails to exclude and promptly effect the expulsion beyond its limits. Such bodies, truly useless and harmful to organic beings, will weaken and disorganise them all the more readily because their action will be more energetic and of longer duration. Of this kind may be: *firstly*, all the non-viable mineral bodies and, more particularly: metals in their different states, the greater part of the saline substances, almost all types of earth and stones emerging from it, etc. *Secondly*, organic matter or matter originating from organic beings, but are non-viable with respect to a given system. The latter are either plants or animals.

174. — But since all bodies composed of viable elements possess, according to their nature and with respect to each living being, a particular degree of viability; it follows that all these stimulants, in general, will excite both kinds of processes and consequently the phenomena of life, but this in a

manner all the more perfect and with a greater benefit for each *individual* the more the particular degree of viability in matter will be more in keeping with the needs of this *individual*. Otherwise, if the property of this viability is much exceeded or does not reach the necessary degree, damages described in (120) or in (160) will certainly take place.

175. — If, then, the external living bodies excite the first and most essential portion of the phenomena of life only by virtue of their own viability, and that viability varies with every *individual*, and decreases in relation to organic elaboration; it follows that the introduction of any substance of this kind in the living being will initially stimulate the organic processes with as much energy as possible; then diminishing in action, it will have no viable force at all. On the other hand, the more this body will exalt organic processes, the more will it lose its viability, and consequently the more it will become capable of exciting chemical processes and disorganisation. This new property, or the capacity to promote its results, grows in the same proportion as the viability diminishes, and is at its *maximum* when it is at its *zero*.

176. — And since the life of each individual can only be maintained by a particular type of matter and by a certain degree of viability, so the living being will be in the most perfect state of life, when the viable matter of which it will make use of will be used in the most just appropriate manner. When the living organism exists in this happy equilibrium, any non-viable substance, or which possesses too much or too little viability, can upset this balance and lead to the

state of disease, the causes of which we shall seek elsewhere. Let us now examine, in general, the results of the action of entities which are too little or too exciting for the organism.

177. — With regard to transformations that that the fed *individual* should undergo, it is important for us to observe, *firstly*, that as soon as every *individual* traverses the circle of life by virtue of the organic powers which are proper to it, which themselves have their limit, that the activity of these powers, the intensity and, consequently, their highest degree of energy, must also be enclosed within certain limits, and have their maximum extent. As a result, when any being is excessively viable, or several of these entities at the same time, carry to the highest degree the organic powers, they themselves close the way to all the next excitation and assimilation, and that subsequent activity or intromission of similar powers, may have no effect whatsoever. Thus, any excessive stimulation produced by viable substances, deprives these substances, and all those of the same nature, of the power of exciting again, in proportion to the intensity of the stimulus. Non-viable bodies do not obey this law at all. *Secondly*:

178. — The more the organic processes elevate beyond measure, the more intense must be the action of the organising power, and the less intense that of decomposing powers or, what amounts to the same thing, the more the organisation exceeds its common measure, the more chemical, or dissipating forces must be weaker. The effect of these stimulating entities, therefore, is to elevate the organic processes

in the same proportion as they decrease the intensity of the chemical processes. The certainty of the exaltation of these latter is the increase of the excretions, the diminution or suppression of which must coincide with the weakening of the processes from which they originate. The more or less considerable extent of the excretions is, therefore, in inverse ratio to the exaltation of organic processes by viable stimuli. This may enable us to appreciate and determine in certain circumstances their relative strength.

179. — But because of their continued action, by their energy, or by abundance, these entities constantly lose their viability and, within organic matter they diminish or become damaged to the point that they cease entirely to be viable, and that they can excite only the chemical processes. It follows that all too stimulating entities introduce into living beings two kinds of opposite phenomena; that is to say, that they at first diminish or arrest all excretions, and later they excite, maintain and elevate them. Therefore, any excess in the organic processes ends in an excretion which corresponds to its intensity. Hence all excessively energetic stimulants, such as wine, alcohol, opium, etc., employed with moderation, stop the excretions and raise the organic processes considerably, while, taken in superabundance, far from exalting them, they provoke all excretions, and often in the most violent manner.

180. — The difference of stimulating action between viable and non-viable entities, therefore, will be that although both may excite and promote excretions in the animal

economy, but the nonviable entities will produce this effect at once and will maintain it in the course of their action, and with respect to intensity and abundance will intensify this effect; while viable entities bodies begin by suppressing or diminishing all excretions, or at least some of them, and that it is only afterwards that they exalt this order of processes. And although the action of some of these substances may be so violent and rapid, that, after having elevated the organic processes to the highest degree, they rapidly lose their viability, and thus excite the exertions; nevertheless viable and non-viable entities will always be easy to distinguish, in that by weakening their dose or energy they can withhold excretions from the organism. In a word, viable entities induce exertions only incidentally and in a secondary manner, while the non-viable ones do, on the contrary, and always in a direct and primitive manner. Can we then say that their way of acting on the animal economy is one and the same?

181. — Because organic processes in every living being have their upper limit which can not be surpassed, whenever any viable stimulants exalt them beyond measure, the further they restrict the limits within which the next stimulation, the more they restrict organic activities and revelations due to emerge. Now, as the chemical or decomposition processes decrease in proportion to the increase in energy of the organic processes, it follows that the former must, in the same relation, come closer to their complete suppression. When the sustained and more energetic action of the viable powers has carried the organic processes to their highest

point and, if I may put it this way, have almost reached them, the chemical processes must touch the lowest possible degree and nearly cease, then the area open to the subsequent action of the vivifying forces is tightened to the narrowest possible limits. If the action of these same forces fills up the small area, then there will be no room for vivification, and all viable matter will have ceased to be so for such an *individual.* But since the chemical processes remain equally suspended, the effect must be that the highest possible point of all vivification is that in which all the chemical processes are stopped, and where none of the organic processes can take place. This is the point where chemical and organic processes end, and consequently life with it. The extreme energy of viable stimuli can thus stop and extinguish *individual* life. It can not be said that, in this case, life ends because of disorganisation because dissipating processes have weakened to the point of complete extinction. It only happens because all the viable entities have ceased to be so for such an *individual*, and thus this organism itself has gone beyond the limits of its relations with the viable matter, on which the course of life depended.

182. — On the contrary, if the stimulating viable entities continually diminish to the most absolute dearth, then all the organic processes must, in the same proportion, be weakened, decrease and go out. In such cases, the chemical processes are more and more exalted; the organic decomposition and the excretions will not cease to predominate until they have attained their highest point, until they have

entirely suspended and destroyed all the organic processes. Under these circumstances the chemical processes attain the highest degree which they can achieve in the living body, while the organic processes have descended as low as possible; that is to say, the subsequent organisation is completely stopped, and the organic decomposition proceeds to the point which approaches the true chemical changes of matter. In his case, *individuals* cease to live by true decomposition, by disorganisation, and by extinction of the vital movement caused by the insufficiency of matter in which that vital movement took place.

183. — All non-viable stimulants are eminently harmful (122) and the more they stimulate the more harm they can do; by acting against the force of the *individual*, they may arrest all its organic processes, or by turning their efforts against the organic cohesion of matter itself, (123) they are capable of destroying the combinations already existing or, finally, deploying an assimilative force, they succeed, in spite of all the resistance of the force of the *individual*, to bring about a new and complete elaboration of the matter of a given entity (125), and, sooner or later, may eventually put an end to the *individual* life upon which they act in this manner.

184. — All the stimulating powers, of course, must act in such a way on the animal economy, and as these ways evidently differ from one another, it is also absolutely necessary that their mode of action also be of a different nature.

CHAPTER XI

FUNCTIONS OF ORGANIC BEINGS AND THEIR INDIVIDUAL ORGANS.

185. — Physical life, as the property of viable matter is, thus, in the general system of the world, a particular kind of movement, a series of changes and replacements which occur in matter. Such changes result from the tendency of natural elements to submit to organisation, together with the action of the local organising forces which mark their kind and nature; then, there is a gradual return of chemical and physical forces and organic decomposition which is its effect. In the first case, the matter subjected to viability and organising strength gradually emerges from its chemical bonds and forms organic combinations in the same proportion, the power and structure of which correspond to the strength of viability and the type of organising forces. But as soon as this tendency to organisation has been saturated and satisfied, it must necessarily also cease its action, and at once this matter solicited by the activity of caloric, and pressed by the influx of an new coming matter, begins to split from the organic bonds of life. The physical and chemical forces awaken, regain their empire, act, and finally

begin to decompose it. Such is the most general idea of the phenomena and transformations to which living matter is subjected.

186. — Nonetheless, the totality of the earth creatures is divided into genera and species. These differ from each other by the difference of structure, which itself depends on their organic power, dissimilar in different genera and species. Now, since the phenomena of life are absolutely identical in the same species, and are dissimilar in the differ ones, it is to organic power that the cause of this diversity must be attributed.

187. — What we call phenomena of life are the acts which manifest their presence. It follows from our principles that although life is essentially one and the same in all animate creation, it nevertheless manifests itself in various ways, according to genera and species. The cause is, therefore, the diversity of organisation which we observe in the phenomena of life. Each *individual* consists of parts and organs which present in it like genera and species in relation to the totality of the organic world, with the difference that their reciprocal union is closer and more intimate. It follows that life, although one and the same throughout the *individual*, must manifest itself in different ways in its different organs.

188. — The state of organic powers being the source of the difference between genera and species, determines also the mode of the phenomena peculiar to both. Similarly, in a given animate being, the state or organic constitution of any

part, whose structure and genus determine the phenomena, is called a *function* of this part, and the manifestation or, so to speak, performance of this function is called an *activity*. The kind of organisation signifies the type of functions, which can only be accomplished when the organs assigned to them are capable of action, and they only become so when they have been suitably excited. Thus, every instance of life revealed, or performance of function in any organ will be the effect of the concurrence of the organic powers and of the exciting powers. *Individual* life will consist of the action of all particular organs. Since the stimulating powers, being viable non-viable, excite organisation or decomposition, of which the former depend chiefly on organic powers and the latter on affinities. Moreover matter, even viable matter causes both organising action and organic decomposition; each activity of an organ is always composed of these two united actions, though not always in an equal proportion; If we desire, in known living beings, to assign to any organ an exclusive force by means of which it can act and be capable of performing its processes, I will ask which force to assign to it?

189. — A great portion of the phenomena of animal life consists of motion and feeling; the former takes place in the flesh, otherwise called *muscles*, the second in the *nerves*. The physiologists, in explaining these two phenomena, the largest and most admirable revelations of life, have assumed a property, or rather a particular force, residing in the muscles, known by the name of *irritability* (*irritabilitas*); and

another in the nerves, which they have given the name of *sensibility* (*sensibilitas*). The first consists in the shortening of the muscles or their contraction by the contact of the bodies bestowed with muscles. The second, having its seat in the nerves, exerts at each of these contacts not contraction, but a sensation. A sound judgement could not possibly admit such a supposition. If, in fact, if the organisation of nerves and that of muscles were identical, and yet the same cause produced a different effect on them, it would then be possible to resort to the supposition of two varying forces. But because we see that these parts have a different organisation; that all that is muscle, excited to an action, is contracted, and that all that is nerve is sensible; we are necessarily obliged to recognise that these effects are only the different modes by which these organs manifest their life. that they can not manifest it in any other way, and that thus the hypothesis of the two different forces is not only useless, but even ridiculous. If, according to such a method, it were desired to assign a power proper to each kind of organisation, it would be necessary to assign it to birds because they fly, to fish because they swim, to terrestrial animals because they walk. Would it not also be right to imagine — another force for the eye which sees, for the listening ear, and thus for the other organs? Finally, if these imaginary forces had any support in nature, they would have to be able to express one of the forces which contribute to the course of animal life. To which one could we relate them? It would not be viability, for it resides in every particle of matter which composes the organic body, it also exists, but in different degrees, in food and drink, and consequently can not be the exclusive appendage of the nervous or muscular parts. Nor would it be to the organic power, which, exists and acts upon all the points of the living machine and in all animate beings. It would be less sensible to compare it with affinities or caloric. If these two expressions are intended to specify the difference of the organic power peculiar to the flesh, and that which accompanies the nervous texture, we can see, *firstly*, that they tell us nothing at all about this difference, *secondly*, if we wish to designate them all by a particular name, we must have a new word for the organic power of each genus, of each species, for that of each organ; in a word, of each solid or fluid living point of a plant or animal. Would we advance the knowledge by this abundance of words in our dictionaries? The physical sciences do not rest solely on words. The organic power is and must always be for us, as to its nature, an eternal secret, and his very knowledge, if we could attain it, would probably still be very useless. Let us suffice to recognise its effects, to evaluate its relations with other forces which act or may affect the economy, as well as the laws of these actions. All organic species, and each *individual* in one of these species, possess, by virtue of organising force peculiar to themselves, and organs which are its creation, its functions, a peculiar manner of being, which belong only to themselves. The same creative power which determines the properties of genera and species also assigned each organ. The function of the salivary glands, for instance, is to prepare the saliva; that of the liver is secreting the bile, etc.; each of these organs constantly expresses their particular life for the duration of their existence: no one has nevertheless thought of establishing and assuming a separate and peculiar force of their own in each of these bodies. Why, therefore, have the feelings of the nerves and the contraction of the muscles, which are only the manner in which these parts testify and manifest their existence, have interested us enough to deserve the recognition in each of them a particular force? Is it because we do not understand or can not conceive of this mode of action? But do we conceive better how the liver and the salivary glands secrete their fluids? Is there a single vital phenomenon in animate nature that we understand better? What, then, are we to think of those to whom it has hitherto sufficed only by this irritability and sensibility to explain all the phenomena of animal life? Or those for whom it consists only in these two properties? What, then, is to be said of eternal disputes as to the difference or identity of these two forces?

190. — The various organs of a given being are what genres and species are with regard to the entirety of the great organic whole, that is to say, each *individual* life consists of all those particular activities brought together. Thus, what we have hitherto said of life in general, its causes, its laws and of its phenomena, applies to each individual being. Each of such beings exists by the harmony of several systems, each of which organises in its own way, elaborates and dissimilates as it wishes a viable substance for

itself, constituted and prepared for elaboration according to needs. All the systems are bound together as one, and procuring viable matter for one another, form a continuous chain, the links of which transmit their own lives to each other. The matter thus organised, traversing through those links, undergoes ever more intensive elaboration until it reaches the highest degree and loses its viability completely with regard to the entire machinery, in the end becoming the material of excretions.

191. — But as in the whole of the living world, we regard as the most perfect beings those who, in the organic scale, occupy the highest rank, who elaborate the most strongly and perfectly the viable matter, and who are thus endowed with a more complicated structure, have a life equally less simple, so to speak. Similarly, in a given individual, we must consider as the noblest and most perfect the organs whose texture, and consequently the functions are the most perfect, and the most complicated. Thus the organs of movement and feeling, peculiar to animals, and more or less extended according to the perfection of beings, must be considered as the most complex and elaborate. A human, from the standpoint of his physical aspect, is considered to be the most accomplished of organic beings, for there is none other, whose organs, functions, and actions are as complicated and astonishing; to his intelligence and his tongue nothing compares in all living creation. After the muscles and nerves, the organs must be regarded as the most perfect organs which are more closely related by their own elaboration, as well as after the human,

as the most perfect in their structure, the animals which are most closely related to humans as to movement and intelligence are regarded as close to perfection.

192. — Although all the laws of life embrace all organic beings, what we have said about life itself and about organisation in general is equally applicable not only to all genera and species, but also to each *individual* and every fraction of an organic being, nonetheless, examining the whole living world through details, we find that each of these isolated members has in its organisation something peculiar to itself which serves to distinguish it from all other beings. Thus, independently of life in general and creation common to all beings, each of them enjoys a mode of life peculiar to itself, and which serves to manifest its existence. We must, therefore, study separately the organism and the vital phenomena of each genus and of each species, and refrain from applying to the whole the particular notions which we shall have acquired separately, studying each of them in isolation. Since organic development of each genus is separate, its particular relations with living beings and with viable matter, the circle of life and other phenomena is also different. It is hardly possible to apply this mode of understanding to all beings in their details, to apply to each in particular the principles of this theory. This undertaking would be interminable. It was only for the man that I proposed to undertake this work, as it follows from our principles, and seek to explain clearly his vital phenomena, and his state of health and disease.

193. — And since the parts and the different organs of a living being are, in regard to it, what genres and species are for the great organic whole, we must endeavour to study in man, whose life we shall learn through details, the composition of his various organs, their functions and activities, their connections with the other parts, and the kind of viable matter necessary for the sustenance of his life.

194. — But by the very fact that the general laws of life extend to every individual being and to each of its organs; it follows that all the processes and actions of its various parts must, above all, be subjected to them equally. We already know (65) that *individual* life consists in the perpetual organisation of viable matter, and in a corresponding dissimilation of organised matter: we also know that life is for the viable matter (148) a perpetual change of forms, and for a given form, an equal change of matter. According to these principles, each organ must therefore be fed by the kind of matter prepared for it and which it assimilates, it must also partly dissimilate and get rid of its own substance. In a word, every organ must constantly renew itself, and that is what its life depends on. This circulation of matter is sufficiently manifest in *individuals*, where we see that the viable matter is appropriated, and disposed of by excretions of various kinds. In each particular organ it is hardly noticeable, because mode of introduction of the viable matter, or the manner in which its excretions are effected can not be seen by the naked eye. Moreover, the organisation and the disorganisation of each of these organs correspond so much, that always

preserving an almost uniform volume and figure, their formation and their decomposition can not be the object of the researches of the observer.

195. — Since each *individual* contains in itself a quantity of viable matter destined to be successively the object of subsequent elaboration; since the matter which composes the solid or liquid parts can constantly assume a new and progressive form in the organism, it is not astonishing that the living *individuals* maintain in an almost uniform state the action of the organs which compose them, and that they do not need aid of the external bodies. They may sometimes live and elaborate the very matter they possess.

196. — For the same reason, all equal circumstances, the more activity and energy the organs of a given being will possess in a limited period of time, the more they will develop and assimilate matter, and the more they will renew themselves. But, on the other hand, the more raw and undeveloped viable matter in will be found the body, the more extensive will be the area of these organic actions which are about to happen. Any action or reaction of an organ must, therefore, in proportion to its strength, excess and duration, diminish the viability of the substance which excites it; and if the sources of viability were ever to be dry, then the energy and duration of action of the organs would exhaust the body itself, consume it, and thus bring about the end of *individual* life. In this way it is easy to conceive how living beings are worn out and destroyed by too strong or sustained action of their organs.

197. — But since each elaboration of viable matter corresponds to a proportional decomposition of matter deprived of viability, if what follows from our principles is true, the increased energy of all the organs or of several of them, must necessitate an additional proportion of excretions. It will, therefore, sooner or later require the necessity of new and viable matter, all the more viable because the exaltation of the activity will have been more sustained and more energetic, and conversely, when after an excess of activity of organs we can see increasing amount of excretions, there is no doubt of either elaboration or assimilation of viable matter.

198. — It is, therefore, necessary to divide all the activities of the organs in an *individual* into those which prepare the viable matter coming from outside, and those which subsequently elaborate the viable matter already present, and perfect its organic cohesion. It is necessary to consider the existence of each living being, as it takes place in the great organic whole; that is to say, to understand that viable matter once admitted into a system, passing through a long series of apparatuses, undergoing an infinite series of metamorphoses and progressive improvements until the highest degree of elaboration possible in a given body has been reached, is finally reduced and by the total loss of its viability becomes no more than the object of the excretions, and is consequently expelled from the periphery of the system.

199. — Not all the viable matter carried into a body, however, is constrained to pass and thus circulate from organ to

organ, just as in the great living system, each lower species is not necessarily called upon a more perfect organisation; but on the contrary, it often happens that, directly decomposed, it immediately returns to the empire of physical and chemical attractions. Indeed, there are beings of the lowest rank, which by virtue of particular elaboration, or by the force of their chemical or organic combinations, can not be elaborated by those of a superior order; it may be the same with the various isolated members of any organic world.

200. — Every organ, every solid or fluid part of the organism is thus subject to this general law, which requires it to receive and elaborate new and always viable matter, by dissimilating and expelling in the same proportion as matter already elaborated and deprived of viability for the form in which it was invested. If this eliminated matter be found to be such, that it may serve the needs of the superior organ to that which rejects it; then it passes under this new form, and the organic excretion of this part becomes thus the food best prepared and most conformable to the needs of that which succeeds it in the organism. Moreover, the first organic part is an essential condition for the existence of the next, which, without it, could neither be renewed nor lived. When we see, for example, that bile and saliva, etc. cease to occur from the moment when the liver and the salivary glands cease to receive the blood stopped by the ligature or section of their vessels, we must necessarily conclude that these animal fluids are elaborated in the blood, and are formed of the elements which this general fluid contained in

its first channels. This organic progression continues until, finally, matter reaches a part which no longer finds above it, to which it may be of some use. This matter being no longer capable of being elaborated henceforth in the body which contains it, and consequently no longer able to live, becomes the object of its last excretions; And it is of such a matter that the individual frees itself continually throughout the course of its life. This last point of perfection is also the highest degree of life which it can attain in the system which contains it. If, then, we wish to measure the strength and perfection of life by the degree and strength of organic elaboration, it is absolutely necessary to recognise that in every living *individual* all the parties do not enjoy an elaborate life; But that there, as in the whole of creation, there are very feebly, and others very powerfully vivified. In order to ascertain the relative perfection of the parts and organs, it is necessary to try to determine their degrees of organic elaboration, and we shall achieve this end only by following, with the help of experience, the progressive progress of the matter which Is organised, its point of departure, its last term, and the way in which it behaves in its transformations. When we study in particular the various organs of the human machine and their various functions, we shall try to solve this set of problems by means of observation.

CHAPTER XII

RECAPITULATION AND ANALYSIS OF THE PREVIOUS THEORY.

201. — Having studied the most general laws of organisation and life, let us account for our work; Let us analyse it into parts, and examine as a whole to see whether we have not abandoned the path of experience and truth.

202. — We have observed, first of all, that every living being can preserve its existence only by the perpetual action and influence of some natural bodies upon itself without which its life comes to nothing. These bodies are water, air, caloric, light and food. We might have added some natural elements, such as electricity and others, if our present knowledge had contained more data or less uncertainty as to their influence, their mode of action, and their absolute necessity for life; we have therefore preferred not to mention nor recall them at all. In the former, we immediately recognised this great difference, that if all these agents were indispensable to life, they were, nevertheless, in unequal degrees. Without, however, having regard to their particular influence, and to the mode of action proper to each of them, we have called this kind of influence *vivifying* or *viable* power,

which makes each of these bodies a rigorous necessity for life.

203. — On examining the influence more closely, we have recognised that this life-giving power is not the primary cause of life in living bodies. On the contrary, the exertion of this power is a certain proof of the pre-existence of life, and the said power is indispensable only for its sustenance. We have, therefore, felt the necessity of resorting elsewhere to find the origin of this life. Going back to the beginning of times, we have established in principle, that from that moment a force must have acted upon matter, and thus formed the genera and species which live today. And we have given this first creative force the name of *organising* or *organic*. Thus the seat, or rather the domain of this power, is not matter in general, but only the living beings to which it is limited, and between which it is distributed. Hence, we have concluded that the origin of every living being is due to the insertion of this force into that being, moreover, what is constantly needed for the sustenance of life and the matter itself is the presence and action of viable entities. It follows that since this power must ceaselessly act in living beings, and by acting to organise these beings, they all are organised without interruption.

204. — These principles, clear and precise, and of notable evidence, have been passed on to the particular consideration of each of the vivifying powers, in order to recognise the manner in which they influence the sustenance of life; we have begun the considerations from food and drink. The

first observation which struck us at once is that not all matter can be indiscriminately elaborated into animate beings, that is, to transform into those beings themselves. In order to discover what sort of matter is reserved the privilege or power to form organic beings, we have thought that the shortest and safest route was to have recourse to the chemical analysis of these bodies. We have recognised that the number of their elements was very limited, and by reason of their exclusive property we have called them *viable*.[16] But since these elements are materially the same in all organic beings without exception, we have concluded that this matter possesses an equal tendency for all organic forms in general and, consequently, to none in particular. It was wrong that some philosophers had attributed to it the faculty of being able to organise itself. But considering also that no other matter can be elaborated into living beings, we have had to recognise that life, in the general structure of the world, is the true heritage and the indisputable property of this matter.

16 Independently of the principles which constitute organised bodies, which we have annotated (41–42), these bodies contain an extremely abundant quantity of lime, which is joined to phosphoric and carbonic acids, and constitutes the bones of animals. But this kind of matter, in all probability, is itself a composite body and the integral product of the organism; what I had long thought of soda and potassium. Iron itself, which is found here and there in small quantities in the living economy, may very well also be a compound body, or be recognised as having a certain degree of viability.

205. — Since life can take place only in viable matter, and only in that which is organised; and matter can be organised only in living *individuals* which, in their turn, maintain their own existence only by perpetual supply of viable matter; it follows that viable matter and living bodies must constantly and reciprocally act and react upon each other, and that life in all cases must be the result of this reciprocal activity. On the part of the *individual* organic power this action can only be its tendency to organise the matter which is introduced into its sphere; and on the part of the viable elements, this tendency is nothing else but striving towards organisation and life in general. It is therefore the *individual* organic power which limits in a way, directs and determines this general tendency of matter, its form, its nature, as well as its organisation and its life. In order that this force might be interwoven without interruption in the *individual*, and could not be extinguished, it requires constant activity on its part, that is to say, to organise itself incessantly; to have at its disposal a certain quantity of matter, from which the necessity of the food was evident.

206. — We have noted that viability, being a tendency towards organisation in general, must be saturated and annihilated in proportion to the progress of matter in the organism; And that thus the viable elements acting on the *individual*, and receiving the proper action of their organic powers, must lose their viability in the same proportion. But as soon as they drop this tendency to a attaining a definite form, it becomes it stronger in successive ones;

and since they seek to free themselves from that in which they are found, they are in this act favoured by the presence of new viable entities, which carry back upon themselves the activity of the organic powers. We have thus learned that living beings constantly replace the matter which constitutes them, and we have given this phenomenon name of *renewal*. Thus it is in the same proportion that the new elements are received and assimilated, that they get rid of substances already assimilated by dissimilating them again. The action of viable matter upon organic beings, therefore, consists in the effort of the matter to strip the constituent elements of the organic form in order to take it upon itself. In other words, viable entities have a tendency to the dissimilate organic beings.

207. — Having then steered our observations to the fact that all matter, subject to the different physical forces, must import with the organised beings a greater or lesser action of these forces, we have researched them and their role in the organic economy. The affinity has attracted our strongest attention. No amount of matter, in fact, is elaborated into organic beings, without losing more or less of its chemical existence, consequently, its quiescent affinities and its cohesion must therefore oppose this change. But caloric, acting incessantly against cohesion and against quiescent affinities, and even being able, to a certain extent, to vanquish and destroy them altogether, must favour and second the new bonds which may take place in the organism. It follows, of course, that caloric favours and facilitates the organic

powers in the assimilation of the viable matter, in the same relation as it operates its chemical dissimilation. Now, since life is basically organisation and disorganization of matter, caloric is therefore its most constant and essential auxiliary, and truly one of the forces which constitute life. The sun, according to me, must be considered as the principle source of heat and light on our planet, so we can also ensure that it is one of the first and most solid causes of life.

208. — From this consideration of organic powers, chemical forces, and heat, we have concluded: *firstly*, that as in every living being there are two processes, one organising and the other disorganising; so also the organic powers dominate in the first, take over, and more or less extricate, matter from physical and chemical laws; while in the second they imperceptibly lose their power, and yield, in the same ratio, to the chemical forces which proportionally rise upon the domain which the organic powers give up. That is why we sometimes call the latter a chemical process. *Secondly*, the combination and union of matter originating from organic beings can never be regarded as purely chemical, since it is in all cases the common result of the concurrence and of a certain balance of organic and organic powers, in which the stronger the latter are subdued, the better the elaboration of matter in the organism, and vice versa in the opposite circumstance. We have thus been led to the theory of spontaneous dissimilation in dead organic beings, or to fermentation. The history of organic matter, which can not ferment, and which is subject to the action of water alone, we have

posited the theory of volcanoes, and recognised the great part which they play on the scene of life.

209. — Plants feed only on water and carbonic acid. These entities act upon them by viability and affinities, and experience the action of organic powers and heat. From the combination of these powers the plant life results. It is for this reason that we have considered them to be the forces belonging to the kingdom of life. All plants have, besides, an alternate need for light and oxygen. The former begins and maintains the organic processes by promoting the formation of oxygen, a gas which supports chemical process helping to form water and carbonic acid. The first process, from the chemical viewpoint, is a true decombustion, and the second, a true combustion. Animals which live from atmospheric air, water, and plants, independently of the action of the powers of which we have just spoken, still experience the influence of organic powers of plants, at least as much as they subsist in the matter which serves them aliments. Seeking then a law of relation between the organic substance and the living being which takes possession of it, we have found that the promptitude and facility of the changes which occur in this matter are in direct proportion to the loss of viability which it sustains; And that the rapidity of the vital circle in every organic being is in inverse ratio to the viability of its ordinary food.

210. — The necessity of renewal derives from the very nature of the organic power, which must always be active. According to this principle, by considering this force as

differentiating according to genera and species, the need also arises for the regeneration and fall of *individuals*. It is for this reason that the life of each of them must be double, generic and *individual*. For sustenance, the first requires renewal, and the second reproduction. The initiation of a new *individual* is nothing else than kindling organic power in matter appropriately disposed by a primary elaboration. Only then, examining the phenomena of development and the successive formation of the organic parts, we have discovered the most beautiful of the laws of nature, namely, that organic power acts at inverse proportion to the masses submitted to it. This is why the origin of a new *individual* taking place in an almost imperceptible atom of matter is also the moment when the organic power is at its maximum, that is, at its highest point. The energy also comes from the fact that the growth of the individual offers a continual weakening of this force by the extension of its domain. And finally, the preponderance which the counter-organic powers are gradually obtaining over it. This is why the increase is only the continual superiority of the organic powers until the midday of life, just as the diminution which has taken place since then is due to the pre-eminence of the counter-organic powers. Hence it also follows that the organic elaboration and the life vary at each instant, according to the constantly different relation of these two powers.

211. — All these results obtained, we have asked ourselves by limiting the question to the animal economy, how the surrounding bodies act upon it? Although we have established from the beginning of this theory that these external agents, indispensable to life, vivify all without exception. However, we have recognised in the course of our research, that each of them possesses its particular mode of action. In fact, caloric is essential to elaboration and dissimilation, it acts on organic beings differently than light which, at least in plants, seems to be sufficiently reserved for decombustion alone. It is different with atmospheric air which' in the two natural kingdoms, is also indispensable for the combustion of carbon and hydrogen. Finally, it is also different in case food and drink introduced into animal bodies. Among those, there is even a difference in the activity of viable and non-viable substances accidentally introduced into the animals. We have concluded that each of these bodies, which we have called vivifying, has an influence on living beings, and relations peculiar to it, but that the general result of all these relations in the whole living globe is the constant organisation and disorganization of the viable matter, infinitely varied, according to the nature of the organic powers and that of the vivifying powers. It remains to be sought now whether this theory is founded on certain and sufficiently proved bases? Let reason, enlightened by experience, make this examination; and that posterity decides.

CHAPTER XIII

A FEW REMARKS ON THE *BROWNIAN* THEORY.

212. — I shall often have occasion and need in the other parts of this work to speak of the great number of systems and theories which have been created in the various schools since the cradle of medicine. All embrace but an isolated portion of the phenomena of life, I have not therefore deemed it necessary to examine them here. I can not however omit the one of *Brown*, created before our eyes, seems to me alone to merit an exception, because it is almost the first to appear to cover the entirety of natural life, and that it is he, who has performed a long and thorough study which I present as a body of doctrine in this work.

213. — The first principle, or the fundamental basis of the *Brownian* doctrine, is the following: "all living beings possess a certain property which causes them to differ after their death from every other inanimate matter. This difference consists in the fact that the external ambient bodies, and some of their own processes, act upon them, and cause the phenomena or processes peculiar to each species of life".[17] These external powers are: heat, food, and atmospheric air, blood, and liquids separated from blood. The functions of the system which produce the same results are muscular contractions, the use of the senses, the action of the brain in the thought and passions of the soul.

This property of animate bodies is called *incitability* (*incitabilitas*). The powers that act upon them take on the name of *inciting powers* (*potestates incitantes*). The common effects of all the inciting powers are: sensations, movements, the intellectual processes, and the different degrees of passion, or the shaking of the mind. But since the result is always the same, whatever be the power which has provoked it, we must also conclude that each of these powers, or their union, always acts in an identical manner, and that none of them can have a mode of action which is peculiar to it.[18] The common effect of the inciting powers is called *incitement* (*incitatio*).

Now, as some of these powers act evidently by impulse, such as touching sensory organs, impulses of blood and other fluids on the walls of vessels, and food on the stomach, air on the coetaneous surface; The others whose mode of action is less obvious, such as, for example, the functions of mind on the brain, must, in its opinion, also act in the

17 Joannis Brunonis elementa medicinæ § X. Observations on the principles of the old system of physic. pag. Lxxxiv. [Joannis Brunonis … Elementa medicinæ. Edinburgi: Prostant venales apud C. Elliot, 1780].

18 *Ibid.* § XV.

same way, since the same result necessarily presupposes the same cause. To designate this kind of impulse, *Brown* employs the word *stimulus*[19] and thus continues the exposition of his system.

Because the powers which act upon living beings are the source of all phenomena of life, and they all act as stimuli — they can not even act otherwise — it follows that life depends entirely and solely on stimuli.[20]

Excitation (*incitatio*) resulting from the inciting powers and general cause of life is in direct proportion to the stimulus and, to some degree, constitutes health at a higher level, and disease at a lower level.[21]

The relationship between incitability and incitement is such that the former is always in inverse ratio to the previous action of the second, i.e., that the weaker the stimulus which has acted on the living economy, and the more concentrated and abundant it is, the more active it has been, and the less incentive there is. The same degree of incentive

19 *Element. Med.* § XVIII.

20 *Ibid.* § XXII. "Quoniam solae potestates communes omnia vitae creant, et solum carum opus stimulans est; in stimulo igitur omnia quoque vitae, omnis sive secunda, sive adversa valeduto, nec in ulla alia re, constuitunt" [According to this statement, however we may understand the matters of life, they are related to plants].

21 *Ibid.* § XXIII.

therefore produces quite different results, according to the present state of the existing incentivity.[22]

The relationship between incentivity and the stimuli is such that when their mutual force is at an average level the stimulus is then the most intense: it decreases the more so as the stimulus has been stronger or the incentivity is greater. Thus the explanation of vigour in mid-life, weakness of childhood and old age. Force is the result of life in moderation, and weakness the effect of both excess and scarcity.[23]

Thus, the more the incitability is accumulated, the more easily it is satisfied, and the less stimuli it can endure. This impotence of enduring stimuli can reach a point in which the weakest stimulus can put an end to life. And to the contrary, the more the incitement has become worn out, the less can stimuli can be endured, until at last again the weakest can put an end to life.[24]

So that incitement and, consequently, life may be ended in two ways, either by stimuli too numerous or too energetic, which elevate incitement to such a degree that they exhaust incitability; or else, by bringing the latter to an excessive degree, and stimuli to the least possible. In the first case, the incitability may be destroyed by one or more

22 *Element. Med.* § XXIV.

23 *Ibid.* § XXV.

24 *Ibid.* § XXVI. *Observ. on the Princ.* pag. XCV, "And on the contrary, the more the excitability has been worn out, the less stimulus does it bear, till again, the smallest portion will produce death."

stimuli combined: it may be destroyed temporarily or forever. Overeating, drunkenness, prostration of forces following an immoderate heat or fatiguing work of body and mind, are examples of a short exhaustion of incentivity. Those of its annihilation are decrepitude, sudden death which sometimes follows gluttony, drunkenness, etc. If a stimulus has completely exhausted incentivity, it will find another which has not yet been active. Thus, a strong drink awakens a man who is overstrained by an excess of gluttony; opium stimuli awaken the sleeping man, etc. But incentivity exhausted in this manner is all the more difficult to re-establish, as the more stimuli have been employed, the fewer remain which can be employed, and which can only be maintained by their aid. The *weakness* which results from this state is called *indirect* (*debilitas indirecta*), because it is not born from scarcity, but from the excess of stimulating powers.

In the progression of this weakness, with incitability decreasing in a constant manner, the inciting powers act with the greatest possible energy; the action of the following is less intense, to the last, which no longer produces any effect. Sometimes, however, by suspending inciting powers, and thereby increasing incitability, this weakness may be delayed for some time.

Another way of annihilating the incitement consists in the want of stimulus. This case of weakness is called *direct weakness* (*debilitas directa*): then incentivity is excessively abundant because it is not sufficiently consumed by the inciting powers; And here too a stimulus may temporarily supplement the absence of another. So good news will calm a hungry man; he who is weakened by the lack of movement finds it easy to sleep if he takes a drink; opium replaces the deprivation of wine.

The seat of incitability in living bodies resides in the nerves and muscles, the whole of which may be called the nervous system. This property can not separate or differ in the different organs; it is identical everywhere, indivisible and the same throughout the system. The proof is that the feeling, the movement and the acts of the mind follow each other instantaneously and everywhere after each effort of the inciting powers; and although several of them operate on different parts, each one reacts on the whole system at the same moment, but still more vividly on the organ with which its contact was most intimate. Moreover, the more incentivity any part possesses, the more fervently the inciting powers act upon it. Thus, for example, the brain and the intestinal tract have more incentivity, that is, more life than the other internal organs. Be that as it may, the effect of each stimulus, considered on the whole organism, is always greater than this same effect on a single part. Such is the most succinct and clearest exposition of the *Brownian* theory; Let us now review its main values.

214. — Here, as in any similar examination, we must first determine the value and certainty of the principles on which this system rests. If they do not appear sufficiently evident and solid enough to sustain it, the whole edifice will collapse and fall of its own accord. But if they are certain, we

must also judge the doctrine derived from it, and scrupulously examine whether in its establishment the founder has not sometimes diverged from experience and sound logic. And *firstly*;

215. — The first principle of *Brown's* theory is not sufficiently evident, nor so striking as to be able to at once acquire a general acquiescence. For by admitting in the bodies a force or a property intended to explain the phenomena of nature, such property must be as simple and clear as possible. Otherwise, reason must demonstrate the indispensable necessity of admitting it. When, for example, I say that "all bodies are heavy", such an assertion does not require proof, because it is the object of constant and general observation, and it strikes the eyes of all. That is why, in explaining the system of the solar world, which the illustrious *Newton* establishes with so much evidence, I do not need to announce the gravitation of the planets towards the sun, for this truth is contained in general demonstration. However, since I can not, by this alone, explain the course of the celestial bodies around the common centre to which they belong, I feel the necessity of resorting to another force, in which the solar satellites, launched in a direct line, follow the tangent curve they describe. This theorem, if it is true, shares the certainty of the preceding, but could not, however, serve as a basis for a complete system of the order of the universe. It could not be commenced thus: *all the planetary bodies obey a force which tends to distance them from the sun by a tangent to the circle*

which they describe. This truth is not so palpable by itself, that it need not be preceded by another. In the same way, if I had begun my theory with these words: *every living being is endowed with a force which tends to organise in it all the matter of which it takes possession*, this principle, however true it may be, would certainly not be accepted by the whole world at the very moment. But if, on the contrary, I say at first that every living being needs atmospheric air, water, heat, light, and food, everyone finds this truth in their own experience, in their own sensation, and instantly falls into agreement with me on this point. If I add that the life of all is connected with a certain structure which is called organisation, and that it is extinguished when the latter is destroyed, anyone can see it in their own experience. It is only then that I demonstrate that we can conceive the organisation of matter only by admitting a particular force which constrains it, and already I laid the first foundations of my theory. And although the source of this force, as well as its nature, is unknown to me, I know, nevertheless, what this force is, what it does, and I have only to pass in the sequel to investigation of the laws governing its action. *Brown* begins with the admission of *incitability*, announcing that he is unaware whether it is a property or a force. Such a proposition presents neither the character nor the essential bases upon which any theory may be founded. He enumerates the inciting powers, among which he lists the very phenomena of life. These phenomena are, for him, effects and their own causes at the same time. He says that the common effect of the inciting powers on incentivity is called incitement, and that this incitement embraces the whole of life, and is the entire cause of it. Yet, if we do not learn, during the whole course of the lecture, what incitement is, and so we also do not know the nature of the incentivity, therefore, during the whole course of the lecture we are not taught what life is. And yet this doctrine was to be a lecture about life.[25] *Secondly*:

216. — Notwithstanding that *Brown* begins by placing the phenomena of life, such as nervous sensibility, muscular contraction, brain activity, etc., among inciting powers, and thus explains simple things by those much more complicated and more difficult to conceive. He warns us at the same time that plant life is similar to that of animals, and by laying the foundations of its theory makes us hope that its system will generally embrace both reigns at once. Discussing the effects of the incentive powers of stimuli he says that they consist in feeling, movement, functions of mind and metaphysical shocks or passions. It is evident that, at this time, he has forgotten the plants, and this error is at the height when *Brown* assigns a seat to incitability. For if this power lies only in the nerves and muscular parts, how and in what manner do all the plants live, which certainly have neither one nor the other? In what manner are we to conceive and to explain,

25 *Element. Medic.* § X. "Quod dictum, quicquid in rebus vitale est comprehendit, eo que ad plantas pertinent" [According to this statement, however we may understand the matters of life, they are related to plants].

in animals, the formation bones, hair, cellular tissue (*textus cellulosus*), blood, and all their fluids? All these parts should be dead, inorganic, foreign to any incitability. And yet why can they be formed only in organic beings? Finally, if incitement dwells only in muscles and in nerves, how is it distinguished from contractibility and sensibility? Evidently by a difference of nomenclature alone. Thus, the entire *Brown's* theory is confined to muscles and nerves, and the laws of life which he proposes are, according to him, the laws of feeling and contractibility, laws which he presumably exhibits with sagacity, but which were already largely known by *Haller* and his followers. *Finally*:

217. — The second of the general principles of *Brown's* theory is, that: "because the effect of all the powers inciting upon vitality is the same, consequently, the mode of their operation must also be the same. Neither can operate in a different mode". Now, whoever has grasped the whole of our doctrine, must also of course recognise that the foundations of his whole theorem are more than erroneous. If it had been true, the nature, so economical of its means, and so simple in its processes, would not have unnecessarily multiplied the incentive powers, of which only one had sufficed, and subtraction of only one of them would have necessarily led to the loss of life. Caloric, water, or atmospheric air should have sufficed for its maintenance in all organic beings. However energetic and judicious is *Brown's* way of feeling and the reasoning, nonetheless, in the exposition of his theory, he has sinned against sound logic, since a conclusion

drawn from these premises is entirely opposite to that which he himself had concluded. The most natural and consequent reasoning is the following: “Since removal of all those powers causes immediate death, and also when only one of them are removed, and whatever it may be”; therefore, “life must be sustained by the influence of the combined action of all of them together, each of whom must also possess a proper and exclusive manner of contributing to this common object”. Thus falls the strongest pillar of the *Brownian* theory, and I do not think that its supporters are in a position to raise it again. For the same reason, but having described the external forces indispensable to life as *vivifying* powers, I immediately added (9–10) that this shared property was only ideal, created by the mind, and I have in fact demonstrated later on, that each of them is called upon to play in the history of life in a different manner. It is for this very reason why I have limited the name of *stimulants* (171) to those powers which instigate living beings to show phenomena of life. These phenomena may, *firstly*, depend on the elaboration or organic dissimilation; *secondly*, they vary in each being, in each of its parts, according to their organisation and the mode they use to elaborate or dissimilate matter. It is true that by considering only one organ in particular, all the powers which can excite its activity seem to operate in an identical manner; but it is only because this organ, has only this unique mode of expressing its life. Hence *Brown*, by limiting his system to the muscles and nerves, has been compelled to allow itself to be deceived by this appearance, and to consider the effect of the inciting powers as the same on all the parts. Could such a doctrine have the name of complete theory of life?

218. — We shall have an opportunity to pass on to the explanation of diseases, which forms the most extensive part of the *Brownian* theory. Now, it is not possible for me to mention this doctrine so famous today without paying the tribute of praise it deserves to its author. It is perhaps the first medical theory, which goes back to the general principles of life, to have tried to discover its laws, and to use it to explain the state of the healthy and ill man. Though we have upset his system, it is impossible not to admire the great and sublime genius of the author. In fact, to generalise things and to relate science to simple and general principles, is always the character of a rich and creative mind; just as it is the seal of the weakness of being lost in imperceptible impunities. It is therefore in respecting *Brown's* genius that I follow the truth. Blessed, if only a step further I am on the path towards its sanctuary.

THE END OF VOLUME ONE.

czących drobiazgach. Poważam zatém genjusz *Browna*, ale idę za prawdą. Szczęśliwy, jeżelim się choć o krok daléj do jéj świątyni przybliżył.

KONIEC TOMU PIÉRWSZEGO.

SPISANIE RZECZY W TOMIE PIERWSZYM ZAWARTYCH,

Z WYKŁADEM TREŚCI ROZDZIAŁÓW.

Stronica.

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ROZDZIAŁ I.

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Służmy poczciwéj sławie, a jako kto może
Niech ku pożytku dobra, spolnego pomoże.
Jan Kochanowski.

Z PORTRETEM AUTORA.

TEORYA

JESTESTW ORGANICZNYCH,

PRZEZ

JĘDRZEJA SNIADECKIEGO

RADZCĘ STANU, AKADEMIKA I PROFESSORA KLINIKI W CESARSKIÉJ MEDYKO-CHIRURGICZNÉJ AKADEMII WILENSKIÉJ, KAWALERA ORDERÓW ŚWIĘTÉJ ANNY DRUGIÉJ KLASSY Z CESARSKĄ KORONĄ I ŚWIĘTEGO WŁODZIMIÉRZA TRZECIEGO STOPNIA, CZŁONKA WIELU TOWARZYSTW UCZONYCH.

Tom II.

JM Paszkiewicz

WILNO,

W DRUKARNI DYECEZALNÉJ U XX. MISSIONARZY
NA GÓRZE ZBAWICIELA.

NAKŁADEM RUBENA RAFAŁOWICZA KSIĘGARZA WILENSKIEGO.

1838.

PREFACE TO THE FIRST EDITION

Issuing the first part of the present publication I cautioned that the following ones might not see the light of day for quite some time. Therefore, I do not understand why the delay should need any apology or justification.

It is almost a universal fate of all writers that the subject they touch upon, while pondering about it, grows out of proportion, therefore their work extends over their original intention. Similarly affected by fate, also I see that this lecture must be more extensive than I had originally assumed. However, I want to persevere in the venture and hope that, in due course, time and stamina will help me bring this work to a successful end.

The first part of this lecture did not grant me much opportunity to continue working; this is partly because I found few readers and partly because some opinions which had reached me proved that either I was not well understood or judged upon old prejudices. Anyway, I decided to leave events develop and not stray from their natural course. Meanwhile, in the bottom of my heart I know that I may have added some value to progress of skills I have been writing about and enriched my language.

No part of my writings will be a complete and full treatise on any part of the medical art: for by scattering here only and their thoughts and considerations on subjects covering this skill I did not want to become a slave to scholarship. If I wanted to remain true to its spirit, I would have to employ myself in words and didactic order rather than only explore the subject matter. This may be a reprehensible undertaking, but because the art of medicine already has enough scriptures arranged according to academic rules and accepted order; so my work does need to be formal.

For this reason the present part, too, of the *Theory of Organic Beings* containing physiological thoughts and considerations, is not a complete and finished treatise on Physiology; though I have tried as much as I could to embrace and explain some parts of this skill in full. Every reader will perceive that the details of this beautiful science very much need a lot of work and experience. It is impossible for one man to take everything upon his shoulders, but young people will find areas where they can shine. And it is enough for me when, having set out the general truths and principles that I will point out where the details need supplementing.

CHAPTER XIV

GENERAL CONSIDERATIONS OF THE HUMAN BEING. DIVISION OF SKILLS RESULTING FROM SUCH CONSIDERATIONS. DIFFERENCES BETWEEN A HUMAN AND OTHER ANIMALS. HIS SIGNIFICANCE.

219. — Having established strong and clear principles of organisation and life, it seems becoming to move to the specific layers and individual parts of organic creation, in order to prove the unchangeability of laws presented in the theory and both laws and particular, isolated events placed here and there, and not included in the links of this massive chain. But such extensive research covering all particulars about living being would be excessive employment. Let us leave them to natural historians into whose domain they fall, and to move further in the task of untangling universal truths; in particular, let us devote ourselves to the science of the being closest to our interests, that is, the human himself.

220. The whole universality of organic beings is divided into plants and animals, and the man is at the head of the last kingdom. Plants, bound to the ground, the air and water, feed on chemical combinations, converting them slowly to organic ones; their structure is fairly straightforward and

almost similar in all parts. Animals, bound to the same conditions and, moreover, to existence of the plants they feed on, have a far more complex structure, usually consisting of many organic parts, quite different from one another.

221. — In the whole system of organic beings, generally, the better viable matter is elaborated, and the organisation furthered, the more abundant and complex are the apparitions of life; the more perfect we assume them to be, the nobler are such organic parts. Throughout this vast array it is difficult to say which term will be the first and which one the last on our own score. But in the intermediate points, whose number is unlimited, transition from one to the other it is very slight: the best proof is great difficulty that the writers of Natural History found in nominating with certainty a point where the plants begin and animals end. Not dwelling too long upon such minor discrepancies, better perfected animals are more than clearly different from plants; and man, formed by social ties, is not less distinctively different from other animals.

222. — Nonetheless, whichever place man assumes in the chain of organic beings, he may still be considered from a number of aspects. The science devoting its attention to man should cover all similar considerations; it should embrace everything to be known about his composition and formation; about the forces exerted upon him and through him; about his relationship to the rest of surrounding natural world; about the beginnings, growth, progress and the end of his life; about the activities and power of all his machinery as well as individual organs; finally, about his social relations, that is, relations with similar beings. The science of man will not be complete if we do not consider him in view of all these relationships and in all aspects; and therefore this science, being immensely expansive, must be divided into many branches and special skills. We ought not to ponder solely about similarities and embrace all these special skills; is it not so that regarding man only in his physical aspect and by pointing out the sources of his relationships with all organic beings and those bearing likeness to him we have to fall back onto the general principles upon which all this knowledge is founded.

223. — But, *firstly:* Reflecting on the human body from the viewpoint of the matter from which it is composed, we either analyse it into the simplest familiar elements or the organic combinations in the various parts thereof contained; We consider the nature and properties of these combinations their similarity identity or the difference of the transformation of one into the other, finally, dissipation and voluntary decomposition. Then, we apply to it *Organic Chemistry* without reservations, or rather learn the properties of the human body chemically.

224. — The same body is interwoven from various parts and organs joined together into a single, orderly, well-balanced and perfectly applied organic whole. As to these organs, they consist of various parts, vessels, channels, hollows, membranes, nerves, etc. By dismantling these organs and

tracing relationships between them, the arrangement, status, disassembling them into organically finer and simpler parts we learn the coarser structure of the human body, or *Anatomy.*

225. — If the body thus composed from different parts is alive (and it should not be considered otherwise); then this life takes place both in the whole organic structure and in all the individual organs, each of which is elaborated and dissipated in a different manner, and differently reveals its own life. Learning the skills from this aspect, which is actually *ours*; the task will be to dismantle it into various parts and organs, to identify their functions and manner of revealing their own life, and to show how they contribute to the life of the whole machinery, and in what way they are within it interconnected, or how life in general influences them, and how they affect each other. In short, the science of life and the general laws of organisation which we have applied to entire animated nature in the first part of this lecture; in this part we shall apply it to ourselves and to all our individual organs; how they work within us with respect to the entire machinery, how species and genera relate to the whole animate world (190). Man in this regard is the subject of an extensive teaching which we would most appropriately call *Zoonomia*.

226. — Life itself, and condition of organic construction can be regarded in two aspects, namely, in the state of complete perfection or, as some say, in the *normal* state which is a state of full health; or in the opposite state or the

state of illness; or, finally, in transition from one to the other. Regarding man in these variants gives rise to numerous parts of the medical skill which, without regard to the finer and less important divisions, comes to the following.

227. — If we study life, both in the man as a whole, and in all his organs while in perfect health, such a skill is commonly called *Physiology.* A healthy man is considered to be one whose general constitution and every organ in particular. Is so perfect and orderly that all his activities and revelations of life proceed easily and in the usual manner. It is therefore the most perfect state of life to which all *individual* activities are pursued without interruption; it is a model of good being most often imagined in the mind, and from which the largest part of living beings more or less departs and goes astray. The science of human disease is called the *Pathology* and again, splits into different branches of the path we shall describe in due time.

228. — Pondering on the state of health and disease, the need arises to consider causes which can lead from one state to another. And thus, *firstly,* analysis of all relations of man with the rest of surrounding natural kingdom; *secondly,* changes which can cause transformation of these relations and the organism in the course of human life. Hence the need to designate in what manner all the elements, organic beings around us and the combinations extracted from them affect us; and what kind of changes that what affects us may undergo; how life and the organism may be thus altered. Finally, all social relationships ought to be identified

and their influence on the status of life and the organism. Such an immense and beautiful skill embraces the analysis of all causes of health and disease, and the teaching of ways and means by which the latter condition can be redeemed and the former restored.

229. — Thanks to these skills, finally, the art of medicine itself is born, focused on identifying all specific cases of impaired health, causes and nature of this impairment or the ways in which these causes can be removed, and on introducing powers which will destroy changes and broken relationships introduced by the former, and bring the desirable order back. All these skills are truly extensive and important; nonetheless important is being attentive to man and his social relations, that is to say, to the creatures of his likeness, and to the changes and transformations to which those relationships have brought him.

230. — Reflecting on man within the framework of the general system of organic beings it is impossible not to wonder about his significance and elevation above other surrounding creatures. It is possible to say without a fault that man such as he is today, in a glossy company, has dissociated from his first parents and elevated himself, if I may phrase it this way, well above himself. Observing him in the wild state, and therefore the way he emerged from the very womb of the nature, yet unchanged by any social relationship, as we used to say, unvarnished, how can we distinguish him from the animals around us? Well, it seems, by external characteristics. This man, if I may use this expression, so

rough, resembles the animals, and is close to the genus of tailless apes: his mental powers are quite insignificant, his soul is asleep and only social relationships and education may wake him up from lethargy and place in a favourable light. But in such a meagre and raw form one can trace the foundations of its future greatness. Recognition and analysis of these elemental powers, and sound history of their disentanglement, of perfection and progress, can be the subject of a beautiful, monumental and very important doctrine: history and science of progress of the human mind.

231. — Animals and plants are in agreement that both belong to the empire of organic beings governed by the same universal laws of organisation and life. They differ in organic formation and development and place which they occupy in the chain of animate beings; so all their difference is due to the elemental creation which assigned their genre and species structure, and in it laid the principle of all future powers and qualities. The same variety and diversity of structure is the cause of differences between one animal from another and, therefore, it is necessary to look there for physical differences between man and the surrounding beings.

232. — Observing the rough structure of plants in general we perceive: that these beings are a weave of vessels, fibres and follicles, whose cell membrane merges, forming various organs and organic parts. The major part of plant fibre is hard, as it is evident in trees, with little sensitivity, not showing movement in reaction to external impressions. In some plants, or parts of them, such as in flowers, namely

in parts responsible for their sexual activity, movement is quite visible and represents, in a way, a passage of the plant kingdom to the animal kingdom. In animals, nonetheless, fibres contracting in response to touch of external objects are far more common, scattered throughout the body, often bound into large masses which are collectively called flesh or *muscles*. Therefore, it is for this reason that spasm of living parts in response to touch of external objects may be considered as one of the important differences between animals and plants. This spasm has always been considered by common people to be the only sign of life, and spasm apparently takes place in the flesh. It is in these organs, therefore, that the cause of all the major animal movements is located that give them importance of the mechanical force, capable of acting on the surrounding bodies in every possible case.

233. — But contracting fibres and some of the related movements do happen, of course, here and there in the plants. Still, knowledge of those spastic movements and irritation which is their cause is the property of animals themselves. This power grows and perfects in them in proportion to the progress of their own perfection, and its true seat are the nerves, so far, despite meticulous investigation of the Physiologists, in the plants yet unnoticed. This is the reason why *Bonnet* sought the difference between animals and plants in existence or non-existence of powers of sensation and discernment.

234. — Both plants as animals collect and absorb the surrounding viable matter, turning it into food and elaborating

themselves from it. Nevertheless, there is a significant difference between them: the former usually feed only on unorganised matter,[26] while the latter will take in and absorb even organised matter. So, as we said in the first part of this publication, plants feed only on chemical combinations, while animals feed on both chemical and organic combinations, and will not survive without them.

235. — And, as the major difference, in general, between animals and plants is in the nerves (233); thus man is most exalted above all other by perfection and the vastness of the system[27]: or, strictly speaking, the entire reason of his superiority is in the construction as a whole. Notwithstanding other special differences that some authors claimed existed between animals and humans, such as the position of the heart, the position of the posterior aperture of the head, larger pelvic area, flattening of the face, specific structure of the uterus, and periodic blood discharges in the female, which are less significant and do not embrace the true causes of human perfection; the most important difference, and all are here in agreement, is the size of his brain and corresponding volume of the skull. This noblest of organs doubtless elevates man above the beasts, but also above his fellow men. We have learned from observations that brain mass of

26 However, a small number of plants which feed on the juices of other plants ought to be excluded.

27 By the nervous system I understand not only nerves themselves, but also bone marrow and the brain.

people blessed with talents and strong minds is far greater than in others.

236. — The powers of the mind most clearly distinguish man from other animals, and the brain is that noble organ to which we owe such powers; so it is precisely there where the most important explanation of our superiority and perfection must be located. Suffice it to say that using this noble part of our body we think and perceive the objects which surround us; that from familiar assumptions we can deduce unknown truths; that we appreciate all relations between things, and between things and ourselves, and we determine our deeds. Our mind remembers past things, connects them to the present and extends to the future, pervades the causes of various events, and discovers relationships between them: and the seat of the mind is our brain. It was the mass of the brain and powers and attributes depending on it, associated with the weakness of physical force that led man to develop and create social relationships that transformed him so that he became almost another creature. Even language, the most beautiful and a property dearest to man, is the fruit of this social union: that was the most important fountain of our perfection.

237. — Judging the place that man occupies in the line of organic beings, considering that he is the highest link of the complete chain of animate entities: considering that the higher living creatures are positioned in this chain, the degree of their organic elaboration is greater; that man, is the head and the top rung of the entire animated world, while

all lower beings represent an introduction and a gradual progress to this greatness of his; all contribute and, let me put it this way, assist this development. For viable matter, circulating through the lower organised beings, rises gradually and prepares for intricate and more perfect organisation, sets ready for those amazing properties which it is about to acquire in man. For this reason, it is necessary to admit that it is very wise and justified to say that the whole animate world has been created for man: for it was necessary to go through a whole series of beings of lesser importance to finally reach the form and sustenance of man.

238. — In the outer form of man and what distinguishes him greatly from other animals is that he walks erect, and his sight reaches from the ground to the boundless space of heavens. Although some scholars tried to make him a quadruped creature; his organism is built so that he can not walk in a different manner: he could have gone against its destiny and the order of nature. We are convinced also by the composition of his legs and hands, the size of the pelvis, and the alignment of the posterior aperture of the head with the atlas. The formation of hands, perfect separation, flexibility and manoeuvrability of the fingers combined with exceptional sensibility of the fingertips, grant man a far better sense of touch and the ability to perform many mechanical works which the animals are not capable of.

239. — It has been said that man is an imitative animal, and *Aristotle* regarded the inclination to imitate as his true and essential trait. Undoubtedly, studying the ways we

employ ourselves, play, and our social ventures, we find that this inclination is most obvious, indeed, we find in the pursuit of imitation true pleasure and real happiness. An obvious proof of this is not only fashion and the contentment we find in its acquisition, but all our games, sports, handicrafts, etc. True, we are most often blind imitators even where we think we are following our own inspiration. But this willingness to imitate is a truly animal trait, not only characteristic for humans, because it is stronger where mental powers are more limited, as we see in children and women. Moreover, the same tendency is seen as strong but clumsy in the entire genus of apes and in all other animals.

240. — The most important pursuit of man, which we do not notice in other kinds of animals, is to continually improve his powers, to exalt himself above other, even similar beings, to impose his domination upon others. This pursuit gives man such great advantage within the system of animate beings that, in view of increasing knowledge and power, our tribe would have long ago covered the whole earth if nature had not appoint certain limits on that propagation, and often had not uses the very same organs of perfection and advancement to restrain and eradicate mankind. Greed, jealousy, cruelty and, above all, ambition is the strongest spring of destruction, and ambition alone is a dam, sufficiently holding back both continuous improvement of man and his unrestrained multiplication. At the same time, increasing numbers suffer from illnesses resulting from indulgence observed in one class of people, and from misery in

another; plagues, which often spread devastation over extensive parts of the globe; extraordinary corruption of our ways; and man has, in his natural powers, both all the means of propagation and perfection, and all the means of his own destruction, spoilage and turning into wild beast again. That is why the history of the human race, though very recent and inaccurate, shows us nothing but peoples and states that come out of elementary barbarity and savagery and climb up to the very top of education, shine and brilliance, only to gradually return to primeval formlessness and viciousness.

241. — And so we are more and more convinced that man who, in the entirety of natural system is almost nothing, in the system of organic beings has a great significance. Moreover, being the owner and master of a large part of the surface of the globe, constitutes a force which continually transforms, reconstructs and moulds it, although his power ends at the superficial shell itself, as he is neither capable of penetrating it nor elevating himself fare above its surface.

CHAPTER XV

ELEMENTS OF PARTS OF THE HUMAN BODY.

242. — Man, as an organic being, living on air, water and viable matter acquired from other living beings, must consist of the elements of this matter, proper to all organised beings, namely to animals (41–42). These elements, on the one hand, can be regarded in chemical terms, as the simplest chemical substances, and on the other, as the simplest organic combinations created on their basis or, in the physiological sense, the simplest parts of the organism. The former are: hydrogen, nitrogen, carbon, sulphur, phosphorus, oxygen, lime, soda, magnesium and iron and the latter can be attributed to protein, jelly, fibre, mucilage, fat, and some specific combinations, specific to singular organs or fluids. (*See* [Początki Chemii], § 839–951).[i]

243. — Considering the organic composition of the human body we observe that, *firstly*: it consists of solid and liquid parts. The former rarely deserve the name of truly solid,

i Śniadecki, Jędrzej. *Początki Chemii*, t. 2. Wilno: Nakl. i dr. J. Zawadskiego, 1807.

being largely soft or semi-liquid; the latter ones are usually sticky and rarely can be called truly liquid: to the extent that softness, flexibility and stickiness are the property of all animal parts; with an exception of bony and corneal matter. In addition, in the course of life, the clotted or liquid state keeps changing in the parts of our body; where, as we shall see, the liquid parts continue to solidify and clotted ones become liquid again.

244. — Organic entities can not be analysed in the manner in which inanimate fossils are analysed, into the smallest crystalline parts; moreover, knowledge of the simplest organic particles is conjectural and arbitrary. Attentive analysis of these parts almost always leads to finding fibres which, in various organs, are dissimilar, being different in the cell membrane and different in the flesh, etc. Thus, this elemental form does not include the cause of dissimilarity of organs. Physiologists have generally acknowledged two organic elements: fibre and plaque, from which they created, for their own use, simpler parts, such as: membranes, tendons, vessels and nerves and, using those simple elements to compose organs, gave them proper names.

245. — With regard to the various hardness of the clotted parts, we can consider bony material as the most rigid, and therefore as a support, and so to speak, a place of attachment for the softer parts and the entire structure of man. After bony matter, the hardest are cartilages, tendons, some membranes, and muscle fibres; whenever they accumulate into larger stacks, they grow into the bone, constituting

flesh, or the so called muscles giving parts of our body form and some rounding. The cell membrane, called by some sticky tissue, is soft and wholly made from solidified jelly, which it indeed becomes when boiled. The softest, and nearly semi-liquid, is the nervous pulp. It is from these parts and vessels that the whole animal body is built.

246. — Physiologists generally accept that there are two beings dwelling in the human body: the body itself and the vivifying spirit. But the latter can not be the subject of physical science, nor is it the subject of our remarks which should not depart from objects comprehensible for senses and experience. Although some Philosophers convey this way of interpretation even into physical sciences, by dividing all things created into material and immaterial and considering the latter to be the spring of all movement and of all change; however, it is necessary to admit that such am interpretation, not being physical, is beyond proof in experiment and experience in reliable sciences based on the testimony of the senses, and can not be taken as original assumption.[28] Moreover, to explore the origin of all forces, so to speak, the first inspiration of matter and, therefore, the primordial source of all transformations of the physical world, is both

28 I have warned elsewhere that, with the intention of explaining only the theory of physical life proper to all organic creatures, any science or non-physical principle that might serve as explanation of existence of intangible creatures can not be touched upon. So I leave these comments to be appreciated elsewhere; they are beyond my realm of my interest and, therefore, ought not to distract my attention.

impossible and unnecessary. It is impossible because in the realm of physical things one can reason only on the basis of certain perceptions and very simple experiments: and we can not claim to have invented an experiment to prove such a claim because, for us, the first causes of things must remain an impenetrable mystery forever; unnecessary because without it, it is possible to appreciate, learn about, and assess all mutual relations between things and ourselves. And, therefore, a sound and reasonable approach makes us want to solely investigate forces in the sense of unfamiliar causes of repeatable changes, by experimenting to show the effects from which we derive and prove their existence and invent laws by which they operate without divulging into their essence. This is the boundary which reliable skills should never transgress. After all, the rest can be left to the Metaphysics, the only ones who are not forbidden to let go of the reins of reasoning, and even go beyond the limits of nature. But beware of shifting this kind of argumentation to the empire of reliable skills.

247. — This miserable and reckless incursion of Metaphysicians to physical sciences has always been a true contamination of human skills; it has always outraged ever-calm and sensible nature researchers; but never has this plague spread and grown so much as it did in our times. The present time Metaphysicians, who have proudly called themselves Philosophers, have indulged in the investigation of the first mechanisms which moved matter; spreading boastful and erroneous declarations about elemental forces, supposedly

acting as the spring from which all the living entities flow; intruding boldly to all sciences where they insolently prescribe laws and indicate rules, though not based on experimentation — solely on conjecture — not based on nature but on delusion: these unproved but didactically announced half-baked claims will be a true stain on our day and age, mocked by posterity. Luckily, this learned madness was a disease of a small number of sages, and did not last long.

CHAPTER XVI

THE POWERS OF LIFE IN MAN.

248. — We have shown and proved in the first part of the present publication that life in the entire animate nature is a kind of movement and a permanent transition of matter dependent on that movement (63–147–148), which constantly organises and elaborates itself. Thus, all the forces that lend matter this kind of movement ought to be called forces or causes of life,[29] but this notion may describe any other powers or properties. Such forces in the entire animate world are, firstly: all the physical properties serving every kind of matter, including the activity of caloric and viability; in specific parts, generic organising power, both *individual* and local. Shortly speaking: because life depends on constant movement and circulation of viable matter; so, in the natural world, it generally depends on causes compelling viable matter to a perpetual replacement and change of form: in *individuals* and in organs it depends on causes maintaining

29 By the force of life I understand, of course, the causes that hold and maintain them. Otherwise, the power of life can be understood as the power or intensity of its intensity: but it is not the meaning of my expression and later it will only come to us to undo the causes of weak or strong life.

form, and dragging behind continuous transformation of matter (148).

249. — Man has a certain characteristic organic form by which we distinguish him from all other beings. So, his existence and life depends on the organic force typical for his genus and species, giving it the primordial beginning, existence and maintains his entirety. This force is exerted perpetually on matter which comes to its realm; thus:

1) commonly and continually:
   a) on organic combinations contained in the body.
   b) on food.
   c) on air and water.
2) sometimes and only accidentally,
   a) on non-viable matter.
   b) on plagues.
   c) on venoms.

Such matter is obedient to physical forces, such as: attraction, affinities, the activity of caloric and light, the laws of concentration or dissolution and, finally, it is more or less viable for human nature. When introduced into the human body, it must act upon it with the power of all these forces as its inseparable properties. But here, it enters in the realm of action a new power, namely: the organising power which, balancing all preceding forces, gives them a new direction and thus grants new properties to the moved matter.

250. — The causes of life in the entire animate nature are as follows: viability of matter — or the tendency to creating organic relationships — and the organising power which

occurs only in *individuals*, and gives him primordial general tendency an assured and manifest direction. Due to the fact that these forces exert their influence on the matter endowed with physical and chemical powers and experience the effects of caloric; therefore, life itself, organic combinations and organisation will be, in any case, a shared resultant of all these forces. Man, an organic being, is also subject to the same law. Therefore, the springs or forces of life in man can be considered in two respects, and divided twofold: to those which give and maintain his form, which commence him and lead him to the highest degree of perfection and formation, and on account of which he is a man and not another organic being; and those which dissipate him and urge him to regenerate the matter he is composed of, forces which slowly bend him, tarnish, and destroy in the end. And because, as in the whole animate world, as well as in man, in all his organic parts elements of life must be the same, and the source of all manifestations of life must be the same; therefore, it would be unreasonable and useless to suppose that there exist more forces of life than the mentioned above.

251. — This remark, though, concerns only the primordial causes, not touching upon the powers which, although are themselves the resultant and manifestation of life may themselves become causes of other manifestations. For in the whole of nature, as well as in the whole organic world, in every corner of the world, everything is interconnected: everything that is a result becomes a cause influencing general organism, organism of species or *individual* organism;

every motion, resulting from preceding causes, becomes a new excitation for further movement and action. And hence, each and every step of progress in organisation and course of life must be a reinforcement and multiplication of active reasons: thus the very manifestations of life must be the cause of new transformations and manifestations. Hence, along with the progress of the organism which, at conception is only a single point, there is continuous growth of its powers and qualities. Hence, though sustenance of each *individual* life depends on perpetual influence and activities of external beings, both the activities, transformations and the inner movement, in brief, all the activities of the living beings must also be the causes of their further life, activities, and further manifestations. Hence, every movement of the body and mind within us is the cause of such a variety of events. And from this we learn how complex the string binding causes with consequences in living beings may be, and how and difficult it is to comprehend this extensive knowledge and to disentangle the knots of this string.

252. — Thanks to the never ending weave of causes and effects, thanks to their multiplication, mutual straining, every living being has unlimited capability for perpetual and boundless extension of its powers. The most remarkable and astonishing example of this phenomenon is ourselves. The human genus has been developing and educating itself for ages, and one can not possibly guess what the limits of this improvement and enlightenment might be. Assessing the savage and crude state of man on the one hand, and his

present education, level of skill and craftsmanship on the other, it must be truly astonishing to tell how far we have come to perfect and magnify our powers: casting a glance forward we need to humbly bow again, looking at the boundless field left for hope to flourish and the potential of endeavours of future generations.

253. — Browsing through publications and looking at reasoning of Physiologists we can conclude that they would hardly be to blame for having never had a clear idea what real forces or causes of life were. Because most often they assumed them to be some more common manifestations of life which, although being, indeed, forces, but only resultant, and largely dependent on life rather than creating it. Such is, for instance, the power of contraction in response to the external impulse, which was given a name of stimulation, and which is to be found not only in live flesh and, therefore, is rather a resultant of life and its expression; contraction itself is one of the assured signs of continuation or complete expiration of life. It is only contraction which becomes a real and very significant resultant force, acting within us and around us. Similarly, nerve manifestations which can, in the end, be interpreted as feeling, are only expression of animal life in the nerves, although they also have been ascribed special strength or animal power. But this life of nerves may be and, in fact, as we will see below, is the cause of many transformations and manifestations throughout the animal economy. In the same way, blood circulation or lymphatic flow, though dependent on life, is the cause of a great number of

events in animals: and yet no one has speculated about a particular force which might be their specific cause.

254. — Some Physiologists also counted among vivifying powers of matter many other properties, noted in animate entities, such as: the power of shrinking, serving some cell membranes; they distinguished it from the power of vibration or contraction of flesh; similarly the power of restoring the lost parts, the power of healing the afflicted parts, etc. In short, assuming that each important manifestation of life has a special corresponding force, the very nature of things compelled them to assume nearly so many such forces as one could observe important and separate phenomena: consequently, bringing more and more confusion to their explanation they finally had to resort to the supposition of existence of as many separate forces as they saw distinct phenomena or separate organs, assuming in each the so-called *proper life* (*vita propria*). This assumption was, indeed, ridiculous and not at all educational: for to say that every organ has a specific force of life is the same as to say that it is organised in its specific way: that last notion word is far simpler and, as expression of common speech, easier to understand.

CHAPTER XVII

CONSIDERATION OF SIMPLE ORGANIC PARTS.

I.

CONSIDERATION OF FIBRE AND FLESH.

255. — Fibre is, so to speak, the simplest element of organic parts, and simultaneously, the most prominent. In plants it is hard, woody, and in a large clusters, it is consists the most important part of their structure, which gives them power and character. We can see examples of great masses of plant fibre in on all trees; completely purified, it becomes flax and hemp. In animals, this organic element is most abundant in flesh, structured in fibrous bundles — this for everyone to see. Soaking meat for a long time, rinsing and squeezing in cold water and then repeated cooking for a long time produces quite clean animal fibre. Thus purified, it is easy to split into thin and barely visible threads, it is — like plant fibre — white and tasteless, hardens in hot water, quickly dries in the air and when dry, it easily crumbles; it dissolves in weak acids; combined with saltpeter acid it produces a considerable amount of nitrogen gas, exposed to fire — plenty of ammonia. It is the organic part with the

strongest animal characteristics and, therefore, one whose organic elaboration seems to be the most advanced.

256. — What are the limits of division of plant fibres into ever-thinner threads is quite impossible to guess. Some Physiologists maintained that these final threads were empty channels that can fill with blood; others claimed they were an aggregate of little spheres, tubes or follicles. All of these worthless beliefs, leading to nothing and having no support in experiments, do not deserve any of our attention. In whatever way the finer elements of the fibres are bound, they seem to be bound together with the cellular membrane which finally makes them visible; that is, cylindrical and soft, and red in humans and animals with red blood. Such cellular membrane fibres are wrapped around each other and bound together, constituting muscle fibres, which are tethered and mixed together, tied by the cellular membrane to form muscles. Never flesh fibres run the full length of the muscle but after an inch or more of length turn to the side, then mix with other fibres and dwindle between them. From this composition of flesh it is evident that they are quite rich in cellular membrane which wraps around fibres and bundles and whole muscles, giving them a reliable coating and separating one from the other. This cell membrane is filled with special vapour and fat, which is in abundance in partitions between bundles and muscles.

257. — Flesh formed this way has its own arteries, veins, nerves and lymphatic vessels. The arteries enter the muscles in several branches which, running along the fibrous

bundles, divide in many directions into many small branches and those dwindle in the flesh. The number of arteries is so great that some Anatomists regarded flesh to be organs composed totally of arteries. But the number of veins branching off the flesh is not smaller. Those suction vessels, which are difficult to trace and discern with the naked eye, however, must be in abundance in the flesh, as the profusion of cell membrane proves. But above all, the amount of nerves entering the flesh and spreading out in muscles is considerable. They normally come in large branches, together with arteries, then branch off in the flesh, spread out and dwindle. This is why some Physiologists regarded muscle fibre as a simple extension of the nerve fibre; but the nature of those two is quite different, therefore, if holding on to this belief, it ought to be said that muscle fibre is its organic transposition and transformation.

258. — Muscles usually end with tendons, especially where they grow into the bone. These tendons are white, hard, resilient, and glittering; consisting, of course, of compact and parallel fibres. These fibres, though they seem to connect with flesh fibres, are not their extension; they differ in nature and boil down completely to jelly: so they rather naturally converge with the cellular membrane, which is probably their origin. In addition, tendons have very few blood vessels and so few nerves that some Anatomists deny them any.

259. — The property of live flesh, which contracts and shrivels in response to external stimuli or by act of will, was

attributed to the fibre itself, though on assumption rather than based on certainty. Because apart from the fact that fibrous structure can be seen in other parts, too, except flesh, in the latter, in addition to the fibre, there are many other organic parts both solid and liquid, such as: nerves, blood and lymphatic vessels, cellular membrane, fatty tissue, etc., so it is questionable whether the property itself serves solely the fibres, or perhaps other parts, too, or rather the entire organ which they are part of. Physiologists, therefore, attribute this property to fibres because wherever the fibre system is evidently present it is more or less visible. On the other hand, wherever the fibres are present, there is a complete muscle with all its the above mentioned parts, so that the fibre, being in the most permanent and abundant part of the flesh, should be considered to be their principle and the most essential part, nevertheless the power of contraction, and let us not digress any more, ought to be attributed to complete muscles only.

260. — This power sooner or later dwindles completely in muscles: 1) whenever the nerves which enter them die, or are destroyed or impaired in any way. 2) Whenever free circulation of blood ceases due to entanglement of vein or arteries, i.e., whenever the source of animal heat essential for organic processes, is repressed. Although experiments, as they are very difficult, do not teach us about the influence of lymphatic vessels on the entirety of this power, nonetheless, presumably those, constituting a part of maintenance of organic processes, also affect them.

261. — Muscle contraction consists in tensing and coming of the two extremities closer together. In this variation, all points of the muscle seem to be converging and approaching the centre and with a significant force. Physiologists have made greatest efforts working on explanation as to which types of muscles undergo a transformation in the course of this action, and left us with plenty of guesses. But, in accordance with our original assumptions, elucidating organic processes and the way they develop is highly unlikely, so there is no wonder that many of these efforts were unsuccessful.

262. — There are those who see the power of contraction also in parts that are not fleshy and in which we do not even observe any fibrous structure; for example, they refer to some plant parts, cellular membrane, some membranes, membrane structured vessels, polyps, etc. It is important, though, to first of all distinguish between resilient contractions of living parts already stretched and returning to their original state, and the movement constituting life thanks to which the living parts can contract, initiated in living muscle by approximation of any foreign body, which the will itself affects, which occurs in a moment, and relinquishes again. And if, here and there in the plants or some membrane parts we observe real movements, similar to those in muscles, it may be that these parts of plants or animals perform them by means of the same, or a similar organ. Finally, it is in the very nature of life that all the organised and living parts are in the state of perpetual movement, and this movement

is maintained by the influence and action of the incoming viable or non-viable matter. This movement, in some parts, is very clear, and not so in other parts; it gradually changes from the most to the least energetic; unfathomable to observe; affected gradually, let me put it this way, and slowly progressing, self- perfecting organisation. Not all muscles are equally perfect, equally shaped and, allow me to say so, finalised; so not all have equally visible muscular organisation, not all move fast and energetically. Nature never leaps in her creations, but takes indiscernible steps going from one thing to another, and we often argue about divisions that she does not know of, because we do not pay enough attention to this exquisite truth.

263. — Not engaging ourselves in unnecessary disputes, because we have not once observed muscular structure where visible contractions occurred in response to external stimuli, in the meantime we will assign this characteristic to flesh. Therefore, flesh, or muscle, shall be a specific fibrous organ so formed that it works whenever, in the course of life, stimulated by some external or inner force; then it vibrates, shrinks and contracts. And this is the only way, clear to the senses, in which life in muscles manifests itself. So long as it works in this manner, it lives; so the experiment of stimulating a naked muscle with electricity, the so called metallic stimulation, teaches us no more beyond the observation that these muscles still have life in them and that the stimulation by electricity is stronger than any other.

II.

CONSIDERATION OF THE CELLULAR MEMBRANE AND ORGANS WHICH IT FORMS.

264. — Dissecting any part of animal body or separating bundles of fibre, vessels, nerves we can see everywhere thin or thick tissue composed of the thinnest white and transparent fibres and plaques woven in various directions, resembling a net, and thus occupying vacant spaces and creating sort of cells; Hence, the name of *cellular tissue* (*textus cellulosus, tela cellulosa*). This organic yarn wraps and binds the fibres, vessels, nerves, in a word, all and the smallest and larger parts of the body and, therefore, it stretches and penetrates everywhere, it is everywhere to be found, unites all parts into one body binds: at times dense, firm and compact, then again mellow or loosely woven like spider web. Such a spongy organ is best visible after rinsing well a part of the water or after blowing air into it, because such fluids, when penetrating between membranes and blowing up the cells, stretch all this yarn and make it visible.

265. — One can imagine the whole organic machine as woven from this cellular yarn, which in some areas thickens and forms outer or inner layers of coating, membranes, tendons, while here and there the bony matter is gathered, giving the whole body a certain firm principle and support to all the soft parts: here and there are ligaments, muscle fibres, lumps and clumps, vessels and nerves: and this is the simplest but true image of animal body. It is possible to formulate a thought depicting all the parts spread around

the cellular membrane as impaired and turned into nothing, this is why the shape of the machine and each organ in particular will still hold and can be portrayed very well.

266. — Cold water and alcohol do not visibly change the cellular tissue in any way, but hot water dissolves it completely and turns it into clean jelly. For this reason, the whole animal machine, and every organ in particular, can be boiled down, i.e., completely dissolve the cell membrane which constitutes it and, by this token, dissipate the very bonding of other parts and bring the entire body down to the bony matter, fibre, and ligaments which will not dissolve in hot water. Apart from loose cellular membrane, there are many organs made up from it completely, which softening them in cold water and boiling down in hot water proves sufficiently. These are, *firstly:* all the membranes, namely the cerebral membrane, the *pleura* and the pericardium in the chest, the *peritoneum* in the abdomen, the periosteum membrane and the one which covers bone marrow in bone hollows; *secondly,* the tubular membranes forming the walls of vessels, and especially the lymphatic vessels. Blood vessels, apart from the fleshy membrane, are lined with another membrane which does not dissolve in boiling water, and is similar in nature to ligaments. The cell membrane lamellae are considered by new anatomists to be a net of lymphatic vessels. *Thirdly,* tendons and tendon membranes, or *aponeurosis*; these organs, attaching muscles to bones and other hard parts, consist entirely of cell membrane, which can be proved best by their complete boiling it down to jelly. *Fourthly,* the skin and all

its extensions, in both loose guts and what lines some empty spaces, namely the inner lining of the mouth, nostrils, and the entire intestinal duct, the inner lining of the bladder and generic parts in the female.

267. — Cell membrane is an ordinary fatty deposit, especially under the skin and where muscles divide. Such oil collects in the cells of this tissue and sometimes fills them, and is elaborated in lumps scattered around those cells and, therefore, it can not be elaborated elsewhere save for the places in which these lumps are located.

268. — The *skin*. The skin, although in general, resembling other membranes, differs from them in some respects. This part of the skin that we call the dermis, which directly covers the cellular membrane and fat spread around it, is a thick, strong and resilient membrane, and the only difference between the cellular tissue and the dermis is its density and strength, because it can be completely boiled down to jelly. On its outer surface is a soft, sticky coating of thin mesh-like tissue, whose compartments are filled with pulp similar to jelly, providing a soft and slushy dwelling to nerve ends, which the skin collects quite a lot of; the anatomists call it *Malpighi's sticky network*. It, in turn, is covered with a thin, transparent and dry film called *epidermis*. It is composed of lodicules which overlap, resembling roof tiles. These pebbles by the finch are only seen in humans, but in some animals, especially in fish, they are also visible. You can not identify this cell membrane as cellular tissue: because its composition is quite different in almost inorganic

and different chemical properties: in hot water it does not dissolve anything and has all the features of a solid protein.

III.

CONSIDERATION OF BONES AND CARTILAGE.

269. — *Bones.* They are the hardest and the most brittle parts of the animal body, consisting of a cellular membrane rather dense, and proper bony material filled with fat in hollows. The cell membrane and fat can be boiled or burned away, and what is left is bony material itself which dissolves in salpeter acid or in hydrochloric acid, and is composed of calcium carbonate and calcium phosphate and in some animals from magnesium phosphate. When whole bones are soaked in salpeter acid or in hydrochloric acid until the earth salts dissolve completely, we are left with the cellular membrane, thick and resembling cartilage, still preserving the form of bone from which it originates.

270. — The outer surface of the bones is coated with the proper membrane, called bone-surrounder (*periosteum),* which is not different from other cellular tissue membranes. This membrane strengthens the vessels crawling over the surface of the bone and supplies them to the bone mass itself. In the bones, the vessels are quite small and less dense than in other organs. Physiologists do not admit the presence of nerves in the bones apart from those that are proper to vessels entering the bones. Indeed, they claim that bony material itself does not even have blood vessels, but that these are present only in the cell membrane, characteristic of the

proper bone. In addition, the inner part of the bone contains a type of sticky fat in a specific membrane or in bone cells, called *bone marrow* (*medulla ossium*). All bones in the body are connected, either directly or by ligaments and, considered together, they constitute a skeleton which is the foundation and support of our entire structure.

271. — Anatomists consider bony matter in a triple state: *dense*, which can be seen in mid part of the long bones; *spongy* which forms the ends of the long bones; and *cribform*, or the sparsely shaped, resembling a net, present in the middle of many bones. Nonetheless, these three states differ only in density: the bony matter is the same in all cases.

272. — *Cartilage.* The hardest organ in our bodies, right after the bone, is the cartilage which most often covers the extremities of longitudinal bones. It is a flexible and elastic organ, white and glossy on the surface, coated with a specific membrane, and equipped with as fine and scarce vessels as the bone itself. The cartilage is nerveless and does not seem to possess any bony material, or at least have very little of it; it can not be dissolved in acids, and by long boiling in water it becomes completely softened, and turns into jelly.

273. — Some cartilage remains as it was throughout the entire course of life (*cartilagines permanentes*), as exemplified by the larynx; while other, being cartilaginous at the very beginning, turn ultimately into bone. Yes, all the bones are soft and cartilaginous at the beginning of life, and in time they are filled with earth salts and turn into bone; all this work begins steadily at certain points which are

unchanging, which is why we call them points of ossification. Such transformation takes place before birth, because the cartilage first appears in the fifth or sixth week after conception, and the first point of ossification appears in the eighth. The clavicles and bones that make up the skull ossify first in our body. After birth, all bones are still soft and unfinished, and the whole work of ossification barely ends with the end of growth. Indeed, it seems that throughout the entire course of life, bone matter constantly enhances, because with progression of age all the bones become harder and more fragile, and many cartilages and other soft parts ossify. And since the development of the bones comes later than many soft parts embraced by them, so their form usually adapts to the latter.

IV.

CONSIDERATION OF THE HEART, BLOOD VESSELS AND BLOOD CIRCULATION.

274. — Blood vessels are equally important in the animal economy as they are extensive; they originate and end in the heart. What we call the heart is a strong fleshy bag placed in the thoracic cavity above the huge muscle which divides this cavity from the abdomen, located between the lungs, and enclosed in a special membranous bag called pericardium. That bag, called *thorax division* (*mediastinum)* is closed between two membranes originating from the merging of the two pleural bags, and dividing the whole of this vast cavity into two parts. It lies in the centre of the diaphragm,

ingrown to it, and encloses the heart and the beginning of major vessels entering the heart. In this bag, always filled with vapour, the heart can move freely, but all the same, the movement is limited to a certain area which it can not leave without tearing the bag.

275. — The heart itself is a formless cone rounded at the end and flattened on the sides. Its flat and bottom parts are turned towards the diaphragm, and rounded part towards large vessels on which he seems to be suspended. The heart is placed diagonally from right to left, so that its principal part, turned towards the spinal column, is higher and more to the right; the tip, corresponding to the lower end of the sixth rib, and more to the left. The principal part, in addition, is terminated by two smaller, partly fleshy bags, which are called *atria of the heart* or *pre-cardiac sacs*. Of these one is anterior and right the other posterior and left. The cavity of the heart proper is divided into a strong fleshy baffle into two, or rather, in humans and more perfect hot blooded animals; there are two hearts, but closely connected, and joined into one organ. Each of these cavities ends with two apertures at the principal part, one of which leads to the atrium, and the other to the artery corresponding to this cavity. And so: the right and anterior heart is connected with one aperture with the right atrium, and with the other aperture with the pulmonary artery; the left and posterior, similarly, to the corresponding atrium, and the other aperture to the *aorta*.

276. — Atria of the heart are also two separate cavities, separated by a strong baffle which, in the foetus, is torn into

egg-shaped opening allow the blood to pass from the right atrium to the left, but the opening is later built up in persons who breathe. The combined trunks of two major veins, the upper and the lower, which the Anatomists call *venae cavae,* open to the right anterior atrium, and this opening is provided with a flap that allows free entry of blood from the vein to the atrium, though does not allow it to return. Similarly, the entrance of pulmonary artery to the left atrium is covered by a flap playing the same role. Extensive apertures connecting heart cavities with their corresponding atriums have free flaps which permit only the entry of atrial blood into cardiac cavity, preventing its return. On the contrary, the apertures connecting heart cavities to the outgoing arteries are equipped with flaps which allow free passage of blood from the heart to the arteries, preventing its return to the heart.

277. — As the blood, flowing through the two major veins (*venae cavae*) to the right anterior atrium, stretches it and urges it to contraction which results in blood being driven to the cavity of the right heart. The stretched walls of this heart contract as well and, unable to reject the blood, send it back to the cavity of the atrium, then drive it out impetuously through the aperture of the pulmonary artery. The same happens in the atrium and the left heart: the blood, infused into the former through the pulmonary veins, stretches it, and also stimulates to contraction; now urged to retreat, unable to return to the veins, it flows back with impetus to the cavity of the heart that casts it into the *aortic* opening.

And so blood flows in, both to one heart and the other heart through the veins and flows out through the arteries.

278. — Arteries or *arteriae,* also called *pulsating veins,* are vessels transporting blood from the heart to other parts of the body; and *veins* (*venae*) are those which transport blood from these parts back to heart. The former are extremely strong and resilient, so when cut across do not drop immediately but retain a round aperture for a considerably long time. They consist of three membranes, namely: cellular, fleshy, and tendon. The latter gives them strength and elasticity, while the fleshy membrane, constituting a true muscle, is believed to be the cause of beating and contractions of those vessels. In addition, the arteries receive an extra coating from adjacent membranes through which they pass, and cellular tissue binds them to other neighbouring parts and provides a fixed and stable environment. The inner surface of arteries is smooth and, due to the special fluid that surrounds it, slippery.

279. — The walls of *veins* are far thinner and weaker than those of arteries. The membranes that make up veins are softer and easier to stretch, but more difficult to tear: the outer membrane has some fleshy fibres, not transverse, though, like in the arteries, but longitudinal. Only two major veins, ending in the atrium of the right heart, have thicker walls and a fleshy membrane resembling this in the arteries, which is why they contract like arteries. The inner membrane is smooth and so flexible that it can be stretched considerably without tearing. Besides, veins, just like arteries,

receive extra coating from the membranes in the vicinity of which they pass, and from the cellular tissue that surrounds them which strengthens and binds to adjacent parts. Arteries are commonly hidden deeper; veins, generally, keep to the body surface and a large part of them is subcutaneous. But the most significant difference in the structure of veins and arteries is in the fact that the former are equipped with flaps allowing free passage of blood from the branches to the trunk, and preventing its return, which arteries do not have. These flaps are folds of inner membrane, and are positioned in groups of two or three, and sometimes four. There are veins in which those are numerous, in other quite rare and, finally, in yet other they are absent, for instance, in brain, thoracic and abdominal veins.

280. — Both veins and arteries often come together, but never arteries bind with veins, unless in their final extremities. It is because dividing into ever smaller twigs, they come finally to such minuteness that they are impossible to see; and then they either constitute the beginning of the narrowest excretion channels or turn into the beginnings of veins. But how does this change happen? How the blood, delivered to the extreme ends of arteries, having satisfied its fate by supplying the material to all organic elaborations, transforms from arterial to venous? How does it enter the beginnings of veins? Are these beginnings of veins merely extensions of the ends of arteries? Or perhaps the apertures of these ends and the first beginnings of veins are separate? — We do not know that. It is certain that the branching of arteries

is so numerous and they may be so minute that there is not even one living point where they would not deliver blood or dispatch the juice elaborated from blood.

281. — There are two main arteries in the human body. The one that emerges from the right anterior heart, splitting immediately into two branches; each of which goes to the corresponding chest cavity, stretches in the lungs and finally ends there. The smallest divisions of this artery contribute to the origin of pulmonary veins which, gathering in ever greater branches, finally, in the form of four branches, enter the left ventricle. The second artery, called the *aorta,* emerges as a large trunk from the cavity of the left heart, dividing it into two larger branches: the *ascending branch* (*aorta ascendens*) and the *descending branch* (*aorta descendens*)*,* the former dividing further to *axillary arteries* and the arteries *ascending towards the head,* supplying vessels to all organs parts of the head, shoulders, arms and hands. The descending *aorta* goes into the abdominal cavity and there, having provided a trunk which gives origin to arteries supplying the stomach, the liver and the spleen, and having supplied all the intestines in this large cavity, finally splits into two huge branches. Each of these, having provided vessels to organs in the pelvic cavity and around it, finally turns into the femoral artery which spreads out and ends, respectively, in the thigh and the leg. The final divisions of all these branches also give rise to veins which, by gathering in larger branches and extensions, come together at last into two large trunks, i.e., two huge veins, *superior* and *inferior*

(*cava superior et inferior*), and those, as we have said, end in the atrium of the right heart.

282. — With such an arrangement of blood vessels it is easy to understand the circulation of blood, knowing the paths which it flows through. All the veins belonging to the *aortic* system come together in two trunks known by the name of *venae cavae*, and thus, having collected blood from all parts of the body, flow into the trunks which, equipped partly with fleshy walls resembling arteries, and rush it to the atrium of the right heart. The extended atrium contracts and, unable to push the blood back to the veins, throws it into the cavity of the heart to which it is connected. This cavity pours it then to the pulmonary artery which, contracting, rushes that liquid down to the final extremities of the arteries, and to where the lung veins begin. Here the blood, after experiencing changes which we shall discuss elsewhere, it gathers into ever-larger branches of the lung veins and, finally, flows to the atrium of the left heart through four branches. From there, cast into the cavity of the heart, it receives new energy from the contraction of the heart, muscular and strong, and flaws into the *aorta*. This huge artery contracts in all its branches and divisions, and thus presses on the blood in its entire cavity until its final destination, where it is received by the origins of veins, and again transports to their major trunks and the atrium of the right heart.

283. — In this way, all the blood flowing in the human body is constantly circulating, rushed by contractions and shrinkage of the great veins, atria of the heart, the whole

heart and the arteries whose beating can be perceived even in very small vessels. Those contractions are not simultaneous; while major veins shrink, the atria are open and relaxed, allowing entry to blood rushed by the former. When the heart atria are closed, the cardiac cavities are open, and when they contract, the atria of the arteries are widened and free. Contractions of the atria and the arteries are simultaneous, just as simultaneous are contractions of large veins and heart cavities. And when the latter close, the former open, and so they alternate throughout the course of life. This is the briefest presentation of blood circulation, combined with the description of the paths through which it flows.

284. — From this description it is clear that the blood, ejected from the left heart and circulating throughout the body equipped with *aortic* branches, returns through the corresponding system of veins to the heart, but not to the same heart cavity. It can not return to it before it is pushed by the right anterior cavity of the heart and before it has rushed through the whole system of pulmonary arteries and veins. And so, because there are two hearts, two major arteries and two great systems of corresponding veins; so are two systems of blood circulation: one *major*, throughout the whole body, i.e., throughout the entire *aortic system*, and the other, *minor* — through the lungs alone; and the blood, constantly urged to movement, perpetually flows from one circulation system to the other.

285. — In the system of aortic vessels, there is one more specific phenomenon: in the abdominal cavity, all veins

originating from the bowels serving digestion gather together under the liver into one branch bearing the name of *venae portarum*. This branch separates again in the entire mass of the liver, mimicking arteries, into ever smaller branches down to the smallest divisions, which supply blood to the lobules which are the construction material of this internal organ, whose task is to elaborate bile. Then again, the smallest branches gather into bigger ones and, finally, collect the blood accumulated from the entire liver, pouring it into the major inferior vein (*vena cava inferior*). In this particular case, the liver vein behaves similarly to an artery and gives rise to a new circulation of blood which is completely different from the two preceding ones.

V.

CONSIDERATION OF LYMPHATIC VESSELS.

286. — *Lymphatic vessels,* otherwise called suction vessels, originate over the whole surface of the body, and in all its cavities, not only in the major ones but also in the slightest, in fact, at every living point: they begin as very fine and impossible to perceive apertures. Their first branches are infinitely small and thin like cobweb, extremely hard to observe. However, they then gather into more substantial branches which converge in peculiar nodes, called lymphatic; from where again they become tied and intertwined in a variety of ways, only to gather into similar nodes several times. The nodes themselves are formed from these vessels, variously twisted, interconnected and tangled, bound by

means of the cellular membrane. Nevertheless, lymphatic vessels are always thin, and due to the transparency of the fluid which fills them, unlikely to be perceived.

287. — These lymphatic vessels which originate at the inner surface of the intestinal duct, and at the time of finished digestion take in the chyle, are known by the name of *lacteals* because they can be observed for a few hours after the intake of food, filled with white juice. These vessels descend later and connect in a further course with other lymphatic vessels, and they all come together into a single common duct, beginning with a large bladder which has been given a name after the location of the *thoracic duct* (*ductus thoracicus*). This duct, finally, ascending along the back of the thorax, enters the left parietal vein and lets the juice it carries into the blood stream.

288. — The lymphatic vessels, originating from the smallest apertures, are designated to drink and suck in all that is at hand, guiding what they have drawn to increasingly thicker branches and nodes, processing the content into a uniform liquid which we call *lymph* and, finally, directing it into the blood through the thoracic duct. This suction, characteristic of lymphatic vessels, is considerable and quite noticeable throughout the organic kingdom and, therefore, sufficient on its own to propel and maintain the free flow of lymph. It was *Hales* who calculated that the suction power in the plant roots equalled to the pressure of a 38-inch column of mercury. *Cooper*, while binding the thoracic duct in dogs, saw that the suction power, providing propulsion to fluids,

was so strong in lymphatic and lacteal vessels that the walls of this duct burst; even though the same walls themselves held the pressure of a two feet high mercury column. Hence, some people understand that this suction power gives even more propulsion to lymph than the power of the heart to blood: that, however, has not been proved in any comparative experiments.

VI.
CONSIDERATION OF THE BRAIN MASSAND NERVES.

289. — The whole inner cavity of the skull is filled with a particular kind of mass which we give the name of the *brain*. This most noble organ, which was admired and examined by Physiologists and Philosophers of all ages, is an essential organ and the most important contribution to greatness of the human race; an incomprehensible source of our noblest powers and the most beautiful secrets of success. This organ, I say, serves us as a means of conceptualising the entire kingdom of nature, in addition to comprehending ourselves. To justify this assertion, it is enough to say that the brain is a physical instrument of thought.

290. — This inner mass is soft, slushy and, in the living creatures, nearly semiliquid; it takes the form of pulp or mash whose organisation is yet little known. It is coated with three membranes, the last of which is bound close to the pulp of the brain. This entire inner organ is constituted, at the first glance, from protuberances and furrows

which penetrate deep into them. It appears to be shaped entirely into curves; inside, however, it is uniform and smooth. When cut across, it shows us two substances: one grey, constituting the superficial part of the curves, being as if the membrane of the cerebral mass; the other completely white, from which the greater part of this organ is formed. Looking at the entire brain mass from above, we see in it an eggshell figure: leaner in the front and wider at the back, and divided into two halves at the centre. However, this division, cutting across from the anterior to the posterior part of the brain, does not penetrate the entire organ: while the two lateral portions are separated, we immediately perceive white medullar matter which holds the two parts together, and constitutes a kind of vault under which all the superior organs are hidden.

291. — The organ of the brain is divided into the brain proper and the *cerebellum*. The latter, smaller than the brain itself, lies underneath it, occupying the posterior and descending cavity of the skull, and is separated from the brain by a membrane formed by the inner lamina of the first cerebral shell. Much like the brain, it is composed of two types of matter: grey and white, but there are no curves on the surface, as it is made of thin and horizontal layers, accompanied by the last of the cerebral membrane coatings. In the middle of the brain, and especially at the very bottom of the skull, we encounter hollows and cavities whom the anatomists gave the name of brain stomachs, as well as bumps and curls, curves and bands, always formed from the confluence of the

two matters, grey and white, denoted by specific names by the anatomists, and we refer the reader to them for description. One can not know tell what the role of such varieties of cerebral matter might play, and what their significance is in the animal economy. One can only conjecture that those may be various brain organs, merging of which into a single mass results in the emergence of the entire mental organ. Furthermore, experiments in this domain are very difficult, and the opinion about them uncertain.

292. — From the middle part of the brain two *medullar* branches emerge which, progressing backwards, converge, finally merge and connect. Similar two branches emerge from the centre of the cerebellum and, advancing, also meet and merge, connecting with the two preceding ones, and forming a protuberance at the point of connection. Thus joined branches of the brain and cerebellum give rise to the so-called *bulb* (*medulla oblongata*), located at the bottom of the skull and advancing towards the opening of the spinal canal where it descends and transforms into the spinal cord. The bulb contains some grey matter, giving rise to that part of cerebral matter which forms the root of the spinal cord. The extension of cerebral matter, descending along the entire length of the spinal canal, is called the *spinal cord*. General cerebral membranes accompany also the spinal cord throughout its length. It is marked by a centre line with a concave line which appears to divide it into two equal parts, and each of these parts gives rise to medullar mass cords, merging on both sides to form nodes and nerves.

293. — It is in the brain, the bulb and the spinal cord where all the nerves take their origin. What we call the *nerves* is the extension of the cerebral matter in the form of strings enveloped in membranes that envelop the brain itself; between them, the outer membrane accompanies the nerves only to the exit from the skull, and the outer one to the organs in which they conclude their course. As they advance, the nerves divide into various branches and shoots, which once again descend and accumulate in the nodes of brain mass bearing the name *ganglia.* And because all the nerves in the animal body originate either directly in the brain or in the spinal marrow, we generally say that the brain is their origin. As a matter of fact, the brain itself and all the nerves are one continuous and unbroken system whose boundaries are the same as the body: the cerebral mass, having its centre and, let me put it this way, its source in its head, it spreads all over the machine, reaching almost all its points.

294. — The distribution and spread of the nerves all over the body bears a resemblance to blood vessels; those have a common source in the heart towards which they converge and from which they emerge; similarly, the nerves have a centre in the head. The vessels leave the heart in large trunks, then divide into ever finer branches and, finally, into the smallest projections reaching every living point of the body; the nerves, similarly, dividing and multiplying perpetually, reach every animate particle and are present nearly everywhere. Just as the heart, so to speak, touches every innard

and every part of every living organ with the final part of smallest of vessel branches, similarly, the brain spreads out and is present everywhere. And if some Anatomists and Physiologists imagined the animal body to be made almost completely from interwoven vessels, so one could equally rightly imagine the human being as a nervous construct. Although, strictly speaking, both ways of understanding are erroneous.[30] From this similarity between the distribution of nerves and vessels in nearly all living points it can be assumed that the significance of the nerves and their effect on animal economy must be in some ways similar to the significance and influence of the vessels.

295. — Both the grey and white nerve matter is intertwined with numerous vessels: the first even seemed to some anatomists as merely yarn of the smallest vessels, which gave birth to two famous hypotheses. They were those who, following *Malpighi's* opinion, regarded grey cerebral matter to be a collection of nodules designed to separate a specific fluid called nerve fluid which was supposed to flow from them by the tiny capillaries constituting white matter and spill onto the entire body through the nerves. They based this hypothesis primarily on the fact that the fibrotic system in the white matter, namely in the bulb, in the spinal cord and the nerves is visible. And since it was impossible

30 Two major and famous pathological systems were based on this error. Because as so-called *humorists* saw in man nothing but vessels and courses; On the other hand, the *solidists*, and peculiarly the unrelenting sect of the famous *Brown* did not see anything but the nerves.

to perceive any hollows in such threads which would encapsulate fluid, therefore some granted it the subtlety of gases or even far greater, as we have in the light or electrical matter. Nonetheless, *Ruysch* overturned this exquisite concept of nodules, trying to prove by injections that all this matter consists of bundles of tiny intertwined vessels. Later experiments showed that even following the most successful injections, between the smallest vessels there is always grey matter left, evidently separate from them, therefore such that its composition can be hardly explained by infusions. In addition, the tiniest blood vessels are found in all parts of the body, although these parts are so many and diverse in nature. *Ruysch's* experiments did not teach us anything about the nature of grey matter and the brain.

296. — *Alexander Monro* considers the entire mass of the brain and nerves to be composed of filaments, that is, twisted and hard threads with no internal hollows. *Fontana* considers the brain to be a special organic mass composed of formless, transparent rolls that fold and form in the shape of guts. This composition was intended to serve both the white and grey matter, with the only difference that the elemental cylinders have in each a different colour, different size and arrangement.

297. — The nerve matter can be easily dispersed in water; the solution is milky and shows protein-like properties: it solidifies in contact with fire, acids, *spiritus vini*. However, this liquid differs from protein in that it contains slightly more oxygen, no alkali, and very little phosphoric salts.

Assuming the character of soap or oil in this matter is wrong. The brain and nerves are no different from the viewpoint of the matter they consist of.

VII.

CONSIDERATION OF GLANDS.

298. — *Glands* in general are organs designed to produce specific animal fluids, for instance, saliva, grease, etc. They are either *simple* (*solliculi*) which can be called follicles or bubbles: and these consist of three parts: the aperture or tubules which is to take in the fluid and partly elaborate it, a sac or cavity which is to hold and refine the fluid, and a duct through which, already elaborated, the fluid retires. The simplest of such follicles are scattered in the cell membrane, elaborating fat which they pour into the compartments of the membrane. Similar follicles are scattered across the surfaces of all membranes lining the ducts or inner cavities of the body, which excrete sticky moisture soaking the inner surfaces of such ducts and membranes. But often such follicles accumulate in great abundance, and form large knots or inner organs covered with a shared coating (*glandulae conglomeratae*), as exemplified on salivary glands, the liver, etc. In this case, the excretional tubules of individual follicles converge and merge, like veins do, forming increasingly larger ducts and, finally, converging into one, which serves as a general excretional duct to the entire follicle, draining the whole digested secretion in its proper location. These ducts may sometimes be quite long and tangled in order to

be able to store the fluid elaborated in the follicles, as it is the case in the male seed duct. Sometimes they are connected by sacks to which the superfluous fluid is poured until it is needed for the animal economy, for instance in the gall bladder.

299. — The source of special juices produced in the glands is blood flowing to such organs, which they in part or completely assimilate and convert into the appropriate fluid. Some of the former Physiologists understood that these fluids are already in the blood, ready and merely admixed, so that the glands would serve only to exclude and separate them from this common juice. This is why the entire work of the glands was called *secretion*. According to our first assumptions, every *secretion* is a true organic elaboration, a true assimilation and transubstantiation of the blood in the organs serving this purpose; so blood is only a nutritional fluid from which the glands, using the power of their organisation and the absorbent force of liquids already contained in them, elaborate a juice specific to themselves. It is therefore a simple organic process, not different from other similar processes, such as digestion or elaborating the chyle, and every follicle can be considered to be a small stomach which elaborates for itself some special kind of juice, not unlike the stomach does from foods and beverages.

CHAPTER XVIII

CONSIDERATION OF GENERAL ORGANIC FLUIDS.

I.

CONSIDERATION OF BLOOD.

300. — The heart, arteries and veins are permanently filled with a red liquid: dense, sticky, easy to coagulate, sweet and salty which we have given the name of *blood*. This fluid, however, is not the same in arteries and veins: in the latter the blood is dark red, almost black, dense, sticky and not so warm; in the arteries, however, it has a beautiful bright red colour, it is more fluent, warmer, and less sticky. Such arterial blood fills the pulmonary veins, the atrium of the left heart and the heart itself, as well as the trunk and all branches of the *aorta*. On the other hand, black blood fills the pulmonary arteries, the atrium and the cavity of the right heart, and all veins belonging to the vascular system of the *aorta*.

301. — The total amount of blood in a person differs according to age, height, sex, temperament and health, and this is why different Physiologists have estimated it differently. All in all, it is impossible to ascertain anything final in this respect. In a mature, healthy, moderately tall person, the amount of blood is usually between 28 and 30 pounds. Out of this quantity, nine parts are perpetually in the veins,

while four are in the arteries, at least as far as such things can be surmised through experiment and calculation. The reason is that the total volume of veins is far greater than the arteries, and the blood, driven by the power of the heart and the contracting vessels, is unevenly distributed and flows faster through the latter than through the former. Physiologists have taken it for granted that almost two ounces of blood leaves the heart following each contraction, and the same amount enters the heart with every diastole. It is therefore a fluid that is in a continuous movement and rush, passing from one cavity of the heart to the other, and in this transition circulating once the entire system of pulmonary vessels, and in the second passage, the entire system of *aortic* vessels.

302. — Thus blood, in constant circulation, experiencing the action of the heart and vessels, being refreshed by the flow of new viable matter; in the lungs experiencing the inflow and activity of the air, is in the true organic motion and alive; once having left its vessels and the normal circulation, it will perish. To deny the blood true life is to deny it organic relationship; in a word, it is to deny that it is a part of organised and organising entities. Such improper and vain arguments over animate or inanimate character of the various parts of the animal body were grounded only in a false image of life, and in the attachment of this imagination to the permanent parts capable of movement.

303. — Blood, released from the vessels, coagulates, and after some time separates into two parts, namely curdled reddish and fluent yellowish. The latter, which we shall give

a name the watery part (*serum*), curdles in contact with fire, alcohol, and acids; whipped in the air, it foams like soap and, mixed with water, produces a whitish liquid. It has a slightly salty taste, and after separating the protein and boiling, it sets into jelly. Burned to ashes, it leaves behind the salt of sodium and of potassium, calcium phosphate and sodium carbonate: the latter gives it slightly alkaline properties, namely, turning plant originated blue colours green. The curdled and red part (*crassamentum*) is separated by rinsing in water, into two parts: the red dyeing part, which dissolves completely in water, and the white fibrous part. The solution of the red part in water has all the properties of the watery part, and just like the former, consists of jelly and protein, but with the difference that, after burning this part to ashes, there remains a brown residue, attracted by magnet and dissolving in the hydrochloric acid, which is the true red phosphate, so that this metallic salt has been assigned all the colour of blood. Considering that the flamed curdles of dyeing matter lend red colour to alcohol, it will be more appropriate to attribute the colour of blood to a particular species of dyeing or extracting substance. The white fibrous part has all the chemical properties of the flesh fibre, and it only differs from it by the fact that, when alive, and during circulation, it is fluid, while the flesh fibre is always solid. The amount of this fibrous element in the blood is not always the same, equalling from 0.0015 to 0.0045 parts. Equally different is the amount of dye and watery parts, and blood is almost never the same. Blood is therefore an animal fluid, a rather complex one, containing the chemical and organic elements which we encounter in other parts, either solid or fluid.

304. — Formerly Physiologists, following *Leeuwenhoek's* microscopic observations, considered the dyeing parts of blood to be round. These small spheres were supposed to constitute nearly the fourth part of the whole liquid. Some authors have even tried to define the size of the spheres by numbers; and so, *Leeuwenhoek* approximates their magnitude to be 1/25,000 part of a grain of sand, while *Haller* claims it is 1/5000 of an inch; *Hales* says it 1/3240, while *Jurin's* estimation is 1/1940. *Leeuwenhoek* further claimed that each red sphere consisted of six yellow ones, and each yellow sphere of six white ones. *Hewson* considered these dyeing components to be lenticular rather than round, and claimed that they formed from a fixed point encapsulated in a blister; *de la Torre* gave them a ring shape. Later, cold and careful reflection on the matter convinced the public that all this teaching was void and insignificant; that the appearance of the spheres was the result of a strong spillage of blood, necessarily signifying its loss; so the spheres were not otherwise apparent unless it was in animals weakened by a considerable loss of blood, and close to death.

305. — Blood, therefore, when in the state of life, is an organic liquid, elaborated by every living being, and thus a liquid whose state at any time depends on the general condition of the whole organism, and alters in accordance with its changes. But also under the general laws of organisation, and this liquid itself, when elaborated, acts upon all the

organic parts which it reaches, and influences the condition and all those parts together. This elaboration of blood, by the power of the organism itself and the life which has been commenced is best seen in the laid eggs and in the foetus in the maternal womb: where, as soon as the developed heart in the form of the beating point is to be observed, likewise, blood will immediately appear in the major heart vessels. It is unlikely to observe anything red in the foetus before the fourth week and in the laid egg nothing before the first forty hours.

II.

CONSIDERATION OF LYMPH.

306. — Despite quite accurate knowledge of lymphatic vessels that Anatomy may boast, no one has yet managed to open any of those vessels to collect pure lymph. Thinness, whiteness and transparency of these vessels make them impossible to discern in the living beings: and Physiologists, assuming that the watery part of blood was lymph, ascribed the physical and chemical properties of the former to the latter. Although this watery liquid flows often abundantly from wounds occupying significant branches of lymphatic vessels, but at that time it mixes with blood and other juices are, therefore, can not be considered to be pure lymph. *Mascagni* however, claims to have collected some of the pure lymph in which he observed the following properties. This watery and slightly sticky and salty juice, solidified in seven to ten minutes after letting, and split into two parts: one watery and abundant, the other clotted, floating in the first, and

presenting the properties of fibre. By boiling the watery part, the larger half of it solidified as a protein, and the remaining portion, boiled and cooled down, produced jelly. So organic elements in the lymph are, according to these experiments, similar to the elements we find in the blood with the difference that the former has no dye parts, far fewer fibrous elements, and more water and protein. However, a question still remains whether or not lymph is one and the same in all the branches of lymphatic vessels? This juice does not flow from one common centre as blood, but as drawn from all the living points of the body, according to the nature of the parts from which it may originate, may differ. The obvious example of this is in that part of the lymphatic vessels which begins in the inner hollow of the intestines, and which, after the use of food, is not filled with lymph, but with chyle.

307. — However, we are not equally familiar with the properties of *chyle* as we are with the properties of lymph. Some Physiologists, seduced by the similarity of colour, compared it to milk to which chyle bears no similarity. Milk itself does not pass straight to chyle carrying vessels but, just as other foods, must be first digested and processed into chyle. Besides, *Halle,* who had managed to gather some of the chyle observed that this secretion, soon after it had emerged from the vessels, curdled and solidified into jelly, and then clang tightly to the sides of the bowl. The curdled outer surface did not resemble cream or cottage cheese, but rather had the look of that curdling which is to be observed in inflamed blood.

CHAPTER XIX

THE EXTERNAL ENTITIES NOURISHING MEN.

308. — To put it properly, all outer beings impacting man and sustaining his life should be called vivifying forces. These beings, though, act either through nutrition or through physical and chemical forces; so the answer to the question about the manner in which they sustain life is in diligent consideration of those forces.

Therefore, the sun, caloric, atmosphere, water, plants, and the surrounding animals are the external causes of our life. We need to recognise each of these causes and identify the way they contribute to our sustenance.

309. — That the sun is the most important external cause of life in plants, we have already shown above (107). And because the life of plants is one of the essential conditions of life of the animals and the primordial introduction to their existence, therefore, this is the first reason why it should be considered the cause of life in general. In addition, it seems unquestionable that we owe the sun the existence of free caloric on the surface of our globe and its movement; to the same actor we owe the formation of oxygen — the two conditions without which animal life would not last even for a moment. Nonetheless, direct operation of the sun seems

to be not less important for us. Experience has shown that people enclosed in the dark, which otherwise enjoy the comfort of life, are pale, swollen and weak. Even the difference in bodily constitution, preferences, mental and physical powers which we can observe in the same kind of people living at different geographical latitudes we do perceive as greatly depending on the influence of the sun; so this charitable star is undoubtedly the most important external cause of life on earth; no wonder, therefore, that there have been and there are nations which worship it as divine.

310. — Far more important, however, is the need for external warmth. Man, it is true, elaborates warmth caloric himself — we shall learn how further on, but, *firstly*, when this elaboration ceases, he will perish, *secondly*, ambient temperature is not indifferent to him. We see the suffering and dying both from superfluous heat as well as the superfluous cold; we can see how a change in ambient temperature naturally affects the state of our senses and our actions. Further reflections on the climate and its impact on differences between people will make this truth a lot clearer. In addition, the essential need for warmth and its influence on organic beings is already largely familiar to us (76, 77, 82, 84, 112).

311. — But almost as strongly and far more clearly the human nutrition is affected by food and drink. The former must be composed solely of the organised entities in order to serve him. But since the relative position of each being in the line of animate entities signifies the viability of matter

acting upon it (166), and therefore, the kind of food; man, who seems to be at the highest peak of these beings, can feed on all of them.[31] That is why there is no other being which could live on such variety of food. And this is one of the reasons for such a great multiplication and expansion of our race on the globe: the industry concentrated on reproduction of beings which are the most beneficial to us has helped a lot.

312. — Rarely, however, man lives on raw and whole organic beings. Experience has taught him that life and organisms in general strongly resist his power of assimilation; therefore, organisms are not turned to food until they have been deprived of life, or have decayed; this is where the industry was born, and transformed into exquisite skill of extracting from animate beings the very organic combinations; and among those to involve in such a selection, processing and preparation so that we may not only weaken or destroy all organic activity in them, but even overpower and completely transform their organic compounds and combinations. And so, it is the ability to save as much as possible

31 Because there is no issue that would not be discussed in the sciences; so the scientists have been wondering: were humans intended to feed on the plants only or on meat? And the answers to that query were searched examining hiss teeth and stomach. Experience shows that the best answer to this question is that humans feed on both, and the elevated position of humans among organized beings teaches us, in accordance with the assumptions of this lecture, that he can feed on almost everything.

the labours of the stomach, assuring the pleasant titillation of the tongue. But this artistry has long crossed the boundaries of true usability, and that is why today it brings more harm to true health, strength and happiness of man than it helps.[32]

313. — The manner in which food sustains us may be twofold. If its organic development is well progressed and, so to speak, closer to ours, such food is easier to assimilate, and in a short time it will renew us and compensate for the losses we have sustained but, due to greatly reduced an erased viability, it circulates in us faster, more rapidly losing its power of viability and becoming material for excretion. Hence, some foods give us nourishment which, so to speak, runs through us quickly and expediently; other again give us nourishment that does it slowly; yet other, finally, act the slowest and in a delayed manner. And that our life depends on such a course and the range of replacement of viable matter; that in this course, unlimited degrees are possible — from the highest to the lowest, and the first and last term of this graduated series are little known to us: that, finally, the degree of viability in particular viable character of food is not yet determined; that is why we will have to comply with more general perceptions and remarks. This important ability, meant to assess true relationship between us and each and every viable and assimilated being, is about

32 From the present assumptions one can and should draw true beginnings of the art of cooking; as I understand — useful and modest.

to begin, and the books by physicians which do not contain a real origin, whereby our attitude to food is to be valued, full of false divisions and propositions, and containing only here and there some valid perceptions derived straight from experience, are not going to teach us much in this respect.[33]

314. — Therefore, foods circulate in us the faster, the further they have progressed in the course of organic elaboration: because animals living on more strongly elaborated matter (117), can renew faster than those feeding on less elaborated matter; moreover viable matter in the living entities is constantly in motion and the power and speed of the apparitions of life depends on the power and speed of this motion, so we can once and for all acknowledge as our original assumption *that man*, *the less viable matter he feeds on*, t*he faster he lives*: *the more the matter is viable*, *the slower the rate of life*.[34] In general, animals give us much better elaborated matter than plants, although also in that respect there are huge differences as to the different types and species of animals as and to animal combinations. In general, animals that feed only on meat and, therefore, continue to elaborate the already well elaborated viable matter, must give us either:

33 However, details of this science can not be derived but from experiment: but this experiment one must be able to judge and to apply the laws of animal world. After all, all physical skills are the teachings of experiment, have to refer to a certain beginning; otherwise experiment is void and useless.

34 This viability is meant as a measure for the whole of an animated world: if taken only in relation to man, the issue is different.

1) matter which has little viability if the degree of elaboration and the power of organic compounds have not yet reached our level; or 2) quite deprived of viability if the elaboration has equalled or passed ours. The former give us the quickest and easiest food to digest, accelerating the course of life and intensifying the power of its manifestation; but it is the food that we have to repeat often. The latter either does not give us any nourishment, or act upon us in the manner of venoms. And that is why we do not use these foods at all or we use them with repulsion, and perhaps only forced by hunger.

315. — But as in various parts and organic combinations, though from very different types and species taken up, the degree of organic production can be one and the other in different parts of the same *individual* (165). So even animals that already have the degree to which we were able to grow organically have been able to extract some combinations that we can continue to process, and thus those that will give us any food. And each other: animals that can serve us as food, or even plants themselves, can put together some combinations that either give us no food or even damage the way poisons need to. In fact, experience shows that even the animals and plants have the most organic combination of which they harm us, and which, when taken by the innocent themselves, become or may be a good food for us. Snakes, for example, have all the venom in a particular flow in the flea bites at the gathering where the most subdued even serve the Indians for good and innocent food. Other venomous animals are harming the same specific or naturally occurring

fluids: or if they close in all the time in the body; this venom is always a special organic combination which can be separated by chemical methods, for example by means of water or alcohol. The same is happening in plants: their venom is always attached to a particular organic combination which, when separated the rest of the innocent plant becomes food. This is very common in some plants whose juice and extract are strongly poisonous and from which the extracted starch is quite a good food.

316. — And from this we learn that, in analysing and valuing the goodness of food, it is wrong to pay so much attention to divisions introduced by natural historians as far as organic combinations which can be extracted from plants as well as animals are concerned, whose impact on our economy ought to be assessed. Hence the knowledge and refinement of Organic Chemistry is a prerequisite to building this skill. Among the familiar plant combinations, in any case, fibre does not seem to serve as food, extract not so much, resin, gum resins, volatile oils, wax and tannin even less: but vegetable mucilage, starch, sugar, solid oil, paste or plant acids can be wholly digested and assimilated. Animals provide us with jelly, protein, fat and meat fibre. The bones themselves do not give us anything viable except for the jelly and the fat they contain. Other animal solid parts are viable only as much they contain these combinations. The same may be said of liquid parts.

317. — Among the used least elaborated vegetable combinations and therefore taking longer time to digest and

assimilate are those: vegetable acids, mucilage and solid oils. All young plants are full of mucilage, well as all those less developed, therefore located rather lower in the chain of plants: the same case occurs with plants growing in shade. Equally little or even less elaborated are the plant acids which we usually find in unripe fruits, and which are then processed into starch, fibre, and sugar. Mucilage is one of the best elaborated plant combinations. Between animal combinations, jelly and fat are less elaborated, while protein and fibre considerably better.

318. — However, considering the fact that the degree of elaboration, even in the same animal combinations or organs, is not the same in all animals, or even not the same in identical place and time: it depends not only on the position of an animal in the chain of organic beings, but also on food (116), way of life, climate, seasons of the year, more or less energetic movement, etc. Examples of this, obviously, can be found, e.g., in milk which is different in the spring and in the autumn, different in young and older cows; indeed, in every country and in every animal species. The same phenomenon can be observed in blood, in meat, in jelly which differ according to the animal species, their age and climate in which they live. Although jelly is less elaborated than protein, and less than fibre, each of these combinations is less pronounced in young animals than in old ones; less in the domestic ones than in wild; less in those feeding on plants than on meat; less in cold than in warm countries, less in fish than in hot blooded animals, etc. From such general

remarks we can assess the value of each kind of food quite well, and draw general rules as to when given food can be best used.

319. — And the more the food is viable, or, less elaborated, the more time is needed to absorb and digest it, likewise, the more time is needed for the employed organs; the slower the course of life of a man feeding on such aliment; the less frequent repetition of taking in food. So, as can we see every day, people feeding on substantial vegetal food, produced, e.g., all cereals, flour, bread baked from flour, legumes and vegetables, need food less often: once taken, it is later digested, and such people are more capable of hard work, withstanding great effort, and are far stronger.[35] On the contrary, those who live only on meat or fish can not withstand work as hard as those former, and need to eat more frequently. So, whether we apply this observation to individuals or to peoples, we can see the most obvious evidence everywhere. Is not the poor class of the people, living on plants alone and withstanding the hardest work, stronger than the middle class, and even more so than the rich? Which of the classes gives us the bravest and best of soldiers? By comparing

35 It is a widely accepted assumption among doctors drawn, as they say, from the experience that animals feed us better than plants and give us more strength. If this is supposed to mean that animal matter is more easily and more rapidly assimilated, and then may be accepted with little doubt; but if it is supposed to mean that by living on animal food we have more strength — this is a completely false concept. What is understood by real power or strength, we shall discuss elsewhere.

the population and power of wild and hunting or fishing nations to pastoral and agricultural nations, are they not the most numerous and the strongest, and the former the weakest and least populous? Thus, in agriculture is the only true wealth and happiness of nations, and the true power of the people.

320. — People living on substantial plant foods maintain their assimilation and their own power with work; likewise, people living on meat maintain all that only by the nature of food. This is how we learn that hard-working people need food of the first kind: those whose work is sedentary, the weak ones, men of letters, etc., need food of the other kind. Equally those, whose rate of life is accelerated for other reasons such as: temperament, illness superfluous ambient warmth, violent motion, passion, strong liquors, are best served by plant foods; those whose rate of life is slower — the animal food. If you want to slow down the accelerated course of life reaching for plant foods, avoid as much as possible those which contain vegetable starch, extract, volatile oil, fragrant and resinous parts, and restrict yourself to mucilage, starch, olive oil and sugar. Jelly from young animals does not differ much from these foods, and plant acids surpass all in the properties of slowing down the course of life, therefore their assimilation is the most difficult, hence their cooling power. And as there are different levels of nutrition in plant, as well as in animal foods, indeed, these foods either by themselves or mixed, can intensify, reduce or modify the rate of life in a variety of ways. Therefore, their scientific

application according to country, climate, sex, temperament, age, and various states of health, and to even the moral deeds of man may be subject to a rather extensive and important science, which can not be the focus of our consideration now, but whose first principles we are reflecting upon at present.

321. — As the plant foods slow down the course of animal life and have cooling properties, the more viable they are, in other words, the less elaborated; so these simple chemical combinations which serve the plants as food should slow down the rate of animal life, and cool it down the most. Such are essentially water and carbonic acid. As everyday experience teaches us: whenever the rate of animal life is excessively accelerated, immediately the thirst is born, and water clearly seems to slow down the said rate.

322. — In general, peoples feeding on fish or meat manifest all these actions and inclinations which imply an accelerated rate of life: they are wild, savage, impetuous, prone to assault, robbery and cruelty: they like hunting and the republican government; they avoid farming and hard work.[36] On the contrary, those who feed only on plants are

36 Natural order of things prescribes that the most harsh and wildest peoples must be those who feed on more strongly elaborated meat, therefore originating from animals, including the live ones, or animals that have brought all their parts to the highest degree of elaboration by energetic, strong and constant movement. However, this severity and impetuosity should be distinguished from real strength and courage. As experience has shown, the mildest but most powerful are the peoples of agriculture, the hunting nations are far more harsh, and the harshest are

mild, timid, modest, pious, patiently standing despotism, even preferring and needing it. Therefore, mortification and fasting established by religions and the law, the ban on animals and pigs holding true for the Israelites, the followers of Mohammed who are prohibited the same meat and wine, all those strategies are well calculated to keep them under subjection. Hence in hot countries, people with a tendency to fervour and exaltation, vivid temperaments, ought to maintain attachment to food plants. In the delicate climates, slow-moving persons, men of letters, people leading sedentary life, craftsmen immobile in their workshops, etc., should avoid such foods. The happy mixing and interweaving of one and another gives rise to modest attitudes and happiest arrangement both for peoples and individuals. And this, in a major part, is the cause of elevation of Europeans over peoples inhabiting other parts of the globe. The popularisation of the religion of Christ, which does not prohibit any kind of food in particular, but happily interweaves the days when meat is consumed with those when it recommends fasting, combined with temperate climate, has led to moderate governments and reasonable laws, to civil manners, making even wars less cruel. The arts and sciences pursue every day the task of popularisation, extension and confirmation of happiness of these peoples forever.

those who feed on meat originating from beings similar to themselves; we have an examples of that in the Caribbean and among many African peoples.

CHAPTER XX

A NUMBER OF TRANSITIONS AND ELABORATIONS TO WHICH FOODS ARE SUBJECT.

323. — A thorough and accurate history of all the transitions which food is subject to from the first entry into the body until it turns into real faeces is, in its considerable part, the history of life and its manifestations. Viable matter, since the moment it enters our body, is constantly elaborated and transformed. Life is nothing but the unbroken chain of elaborations and transformations of matter that constitutes us. Due to the fact, however, that viable matter enters the human body not only in the form of food, and the farther it precedes in organic elaboration, the more complex those transformations are and the harder to understand, we shall debate only the primordial ones here.

324. — When external things touch and affect us, we also affect them. The first food transformations take place in the mouth itself, where they are meant to be fragmented, turned into pulp and dissolved in the saliva. This transformation is twofold: *mechanical,* damaging all organic composition, and even obliterating any trace of it when food is ground into pulp, and *organic,* with the process starting to

dissolve the food in the saliva. The former is the preparation for the latter, and it makes it easier the more perfect the former is. This dissolution does not end here, it merely begins, and there is too little time for it in the mouth. The food, duly ground and mixed with the saliva, passes down to the stomach where all circumstances favour further dissolution, and where food encounters the juice with many saliva-like properties. Only here the food dissolves completely.

325. — The *stomach* is a kind of sack composed of flesh fibre, and placed at the beginning of the whole digestive tract. It is equipped with numerous nerves and vessels, some of which end as the smallest apertures on its inner surface, as at least those, who suggest that those apertures elaborate gastric juice, understand their role. This juice is very specific, increasing in amount along with arriving food and saliva which we continue to swallow. The sack is placed diagonally and across, and is in a perpetual, though slow movement, characteristic of the entire digestive tract, which advances all material contained therein in the downward direction. Such a continuous and slow movement mixes perfectly the digested pulp with the juice and thus dissolves it. The temperature itself, usually equal to 32 *Reaumur*,[ii] facilitates such dissolution.

326. — Organic solubility is a specific phenomenon, differing from both simple dissolution and chemical dissolution, and characteristic only of animal or plant economy. In

ii 32° Réaumour — +40° Celsius.

this process it is not only solid or semi-liquid entities that change into the liquid state with the help of animal juices but, on top of that, these juices give them a share of their nature by donating this feature and, upon dissolution, constituting a liquid, uniform not only in density but also in animal nature, as well as in viability and in the degree of organic elaboration. Hence, the matter which constitutes animal juices, elaborated from blood, which has already lost much of its primary viability and was to become excretion material, lending newly arriving elements its own organic strength, recovers partly its viability, and may be temporarily fit for further use in the animal economy. And so, food and drink refreshes us temporarily: and everyday experience tells us that assimilative juices, if they have no fresh matter upon which they might act, are rejected beyond the limits of the organism, for example: saliva, gastric juice, bile, and male semen.

327. — The dissolution of food in the gastric juice is called *digestion* (*digestio*). It may be shorter, easier or more difficult, depending on the nature of food. In general, meat and better elaborated foods are easier to dissolve than plants; organic combinations extracted from them dissolve faster than whole organic parts; liquids faster than solids. For this reason, the stomach and digestive tract of animals living on meat is very different than the stomach and guts of animals whom plants serve as food and, in the former, it is always far shorter and simpler than the latter. Indeed, in the latter, instead of one stomach we often find several; so that

fodder difficult to elaborate and dissolve for the first time round may remain in the stomachs longer. On the contrary, in animals feeding on meat there is only one stomach with the upper aperture positioned very close to the bottom one, and its protruding left part, in which food usually stays longer, is far less extensive.

328. — The thick juice into which the stomach fluid and food turn when completely dissolved is called *gastric milk* or (*chymus*). It is quite a uniform liquid, greyish yellow in colour, rather mild and sweet in taste. Once the perfect dissolution of the food has been completed and the juice has been elaborated, we say that digestion is finished: humans usually need five hours to complete digestion, though some animal and liquid food may already be digested in half an hour; other foods take dozen or so hours or several days, remaining not dissolved in the stomach.

329. — There are, however, some foods or organic combinations such that either can never be digested or often resist the absorption power of the stomach juice. Such parts, if they can dissolve without organic transformation in this juice or in chyle, or at least be firmly suspended in it, are sometimes sucked in and swallowed by the suction vessels, and enter the blood or in the faeces unchanged. Examples of this can be found in fragrant parts of asparagus or dyeing rhubarb which can be seen unchanged in the urine. This often happens with medicines based on non-viable bodies, as evidently seen in the example of mercury and on dyeing parts of common madder that reach the bones: we can

observe this phenomenon in many fragrant parts used to season gingerbread or marinade meat. If the undigested parts are too thick, nor they can be dissolved in the chyle, then they will pass unchanged through the entire digestive tract, for instance seeds and fruit stones.

330. — The time in which the use of food should be repeated differs according to its nature, according to personal disposition, largely dependent on the different rate of life; according to temperament, sex and age. Once food has been dissolved, it flows down through the lower aperture of the stomach to the intestines and the stomach is then empty. At this time, new gastric juice slowly begins to accumulate and remains deprived of labour, which gives us a kind of unpleasant sensation warning about the need for taking in new food: very much like any significant reduction or suppression of whichever organic activity associates with an unpleasant sensation.

331. — Multiple experiments undertaken with *gastric juice* have shown, *firstly:* that it does not have the power of dissolution when organic beings are dead; this is why it has no impact on the walls on the stomach in the living beings, or it is ineffective; it may also be the cause of hunger. But after death, as taught by *Hunter's* experiments, it will dissolve even those walls. This assertion agrees with the original assumptions of this text, but only as far as the statement that gastric juice encounters unequally stronger resistance from living creatures than from the dead ones; although this by no means signifies that, in some cases, it should not be

capable of overcoming this resistance. As experience teaches us, fish swallow other fish when the prey is still alive, fowls swallow whole insects and that is why they digest them completely. Some people seem to be killing and digesting their own worms. *Secondly:* that in meat-eating animals, gastric juice dissolves only meat, and in those feeding on plants, only plants. *Thirdly:* that the power of dissolution of the gastric juice lasts for some time after death, too. Nonetheless, this perception should be limited only as taking place in persons or animals who have suddenly died from overstraining or removal of some important vital organ. Wherever life slowly withers because of illness, the gastric juice relinquishes its organic power together with other parts of the body. *Fourthly:* Too strong juncture in viable matter resists the influence of the gastric juice, and often overcomes it. It can not be otherwise if we regard digestion as pure organic dissolution. Hence we see that the outer coating of grains, fruit, etc., prevents their dissolution. Therefore, we find along the whole digestive tract undigested fruit stones, seeds, fruit pips, bones, etc., although these beings — as organised ones — are composed from viable matter. Hence the fowl either damages hard shells with a beak, or a bird stomach is so strong and hard that it can grind those shells to powder, or to intensify this grinding and milling, birds may swallow pebbles together with grain. Hence the preparation of such grains to be digested by milling, overcooking, fermentation. Hence, the abomination of swallowing such food which the teeth can not grind to pulp. The most important condition attached to the action of gastric juice and proper digestion is the state of life, the power and degree of which predisposes the power of the gastric juice; it can not be otherwise because digestion is an organic activity. *Haller's* and *Morgagni's* observation that, having tied up the eighth pair of nerves and destroyed the digestive power of the gastric juice, which shows the need to consider the influence of nerves. As the nerve pulp belonging, as it transpires, to all secretions, and influencing their condition must also affect the elaboration and properties of digestion juices

332. — Gastric milk (*chymus*) has no longer any similarity to the food from which it is derived but it is the animal juice proper for us, nearly identical regardless the food it originates from.[37] It passes through the bottom aperture of the stomach to the bowels and, at the very beginning, it encounters new abundant juices which further dissolve and process it. These most important of these are two: *pancreatic juice* and *bile* to which physiologists add the proper bowel juice seeping from the entire internal surface of the bowels, just like the gastric juice. The first of these juices is watery and, as much the experiments have shown, quite similar to saliva. Bile, as chemical analysis tells us, is a kind of soapy animal juice, composed of protein, soda, and a particular greasy essence. However, its activity can not be explained

37 I say close because the nature of foods influences the condition of all organs, therefore, after the first elaboration it must be less transformed than following subsequent ones.

only chemically nor derived from the general properties of soaps: this juice must undoubtedly have organic power in a living body, just like other juices, and by this power transform and improve the chymus. The thick and dense chymus thins and whitens right in the first bowel and takes the form of a uniform, perfectly dissolved substance. Thus elaborated, it is called *bowel milk* (*chylus*), and the new type of organic elaboration is the work of pancreatic juice and bile. In this form it slowly flows along with the movement of the bowels through their hollows, where it seeps into the apertures of suction vessels, here called lactic vessels.

333. — This part of the lymphatic vessels which have their origin on the inner surface of the intestines and are called *chyle vessels*. Their role in the progressing digestion and elaboration of chyle is to suck the chyle in and transport it as far as the general collection point of all lymph (*cisterna Pecqueti*) is located. Throughout this progress, chyle is ever better elaborated, especially when mixing with lymph which is a well-elaborated animal juice. The lymph, being collected over all internal surfaces of the body, is indeed, composed of all its molecules which are, so to speak, melted, are swallowed by the suction vessels, and which are often brought to the highest degree of elaboration; the juice would be excessively elaborated poorly viable if it was not refreshed by the most viable matter arriving from the surface of the bowels every now and again. This refreshing happens through organic dissolution, namely, by mixing the most thoroughly elaborated liquid with the fresh and still very viable liquid.

This is why it is easy to understand that the lymphatic system elaborates quite strongly all kinds of matter entering the body, and does not let the raw blood through until it acquires quite strong animal characteristics; therefore it is a very important organ of animal assimilation. And since it can not penetrate blood otherwise but through these vessels, they are the general store of viable material from which this most important animal fluid is elaborated.

334. — We will easily find out that such mixing and mutual dissolution indeed takes place in all lymphatic vessels although these vessels absorb, or at least seem to absorb all these particles of the living body, all juices, air, chyle, water; however, the lymph, wherever it might seep from, appears to be, as far as we know, one and always the same fluid: what is proven by inflicting casual or intentional wounds of these vessels. In the glands, where by twisting and multiple intertwining of these vessels the rate of the lymph flow may be significantly delayed, this mutual dissolution and thus elaboration of the lymph, is greatly improved. No wonder, therefore, that Physiologists noticed a long time ago that the lymph emerging from these glands is better characterised than the one which enters them.

335. — And as there are some natural bodies and some organic combinations that resist the assimilating power of the stomach and intestines; there are also such which the lymph can not dissolve and transform. One example is mercury and some other metals, some fragrant beings, venoms and plagues. If such beings are mild and just will not

assimilate, the lymph vessels and lymph does not experience any change from contacting them. But if they are sharp, biting or themselves exert on them their power to dissolve or absorb, then, in the first case, vascular inflammation takes place, especially lymphatic nodes, in which these beings remain for a longer time; in the second case, the lymph itself undergoes morbid transformation, which also causes vascular and nodular disease.

336. — Finally, in a state of complete health, the suction vessels, or rather their initial openings, seem to refuse to take in themselves anything but such beings which are harmless, according to the same property of the organism, according to which animals refuse to bite on and consume food which is wrong or totally harmful; this property is more than in the entire organic world. But this power can be completely lost under the influence of a disease or over-straining the system of vessels, which supposedly constitutes the real reason why snake venom and mad dog bite do us no harm unless there is a wound; where the damaged and ailing vessels assimilate it, introduce into the body bring it into a body, which would never happen in the state of health. For the same reason venereal venom never becomes a common disease until the formation of ulcer. Finally, the cause may be that the infectious diseases are not contagious without disposition, and this disposition must depend on the altered sensibility, action and, so to speak, dampened instinct of suction vessels.

337. — The final mixing of chyle with lymph and its elaboration in lymphatic vessels takes place in the *thoracic duct*

(*ductus thoracicus*) in a vast cavity, or a *cisterna Pecqueti,* as is called by the anatomists. Here, the entire lymphatic system, beginning at all points of the body, has its centre, and here lymph is collected; here the chyle and lymph receives, so to speak, a particle of life and the organic stigma from every atom of elaborated and organized matter. From here only this whole fluid, now strongly animalised, already bearing the character of the *individual* being which has elaborated it, flows into the blood and from there it is transferred right to the heart which is close, and which blends it perfectly with blood and casts it into the lungs and, therefore, into the total mass of circulation. We shall debate its further processing below.

CHAPTER XXI

FURTHER ASSIMILATION OF FOOD. ELABORATION OF BLOOD.

338. — From what we have said so far, it is clear that blood can be only elaborated from the lymph and chyle. The lymphatic vessels infuse lymph and chyle into the blood. The lymph is collected from all parts of the body and mixes with chyle, then flows into the blood. Analysing the lymph, we shall find in it almost the same organic combinations as in the blood, except only for a dyeing part; so the transformation of the first fluid into the other one must be quite easy. The lymph, entering the blood vessels near the heart and then immediately moving forward into the right cavity with the blood, mixes *firstly,* due to swift circulation of blood and contractions of the major veins of the right atrium of the heart as perfectly as possible with this fluid; thus immediately experiencing all its organic activity, and on its part exerting its own; and together they begin to acquire the nature of a uniform fluid. *Secondly*: as a result of this action, caused both by the lymph and blood, the animal nature in chyle may be elevated, and maybe even transmutation of the protein particle in chyle into a

substance that we call fibrils[38] in coagulated blood takes place. This transformation of chyle and lymph into blood happens, from the organic standpoint, due to action of the blood itself, the heart and vessels influencing these two fluids; from the chemical standpoint, due to the intake of nitrogen in the lungs to which the right heart rushes the chyle and lymph, just mixed with blood. The dyeing part elaborates slowly, throughout the circulation, namely through the lungs where arterial blood is formed. Those who believe that red iron phosphate alone is the dyeing part of blood, suspect that there is white iron phosphate in the chyle and lymph which, after the chyle has entered blood and mixed with the sodium carbonate, changes into acidic phosphate, with the excess of the base, so white becomes red.[39] Moreover, they suppose that this red colour is increased by raising the oxygen content in the lungs.

339. — The chyle, mixed in this manner, first into the lymph and then into the blood, acquires more and more

38 This substance with chemical characteristics of the fibre can be in the blood from two sources: *firstly*: by processing part of the protein; *secondly*: by the lymphatic vessels melting and assimilating the meat fibre. I hold this is the second source more credible because: 1) organic parts are not formed otherwise but from parts of the same kind; 2) that *Mascagni* found liquid fibre in the lymph (306).

39 According to such clarification, it should occur in the lymph, which does not happen. Besides, as I have already mentioned, the colour of blood should be attributed to a specific dyeing entity which dissolves in alcohol.

animal nature; and of course this change is the faster and the easier the more animalised it had been before. Because these transformations usually take place in the right heart and in the lungs; therefore, these organs are truly important organs in the formation of blood, i.e., *sanguination*. The lymph, too, being very fluid, dilutes the blood and makes it more fluid, which is so thin that it is easier for it to pass through the extremities of pulmonary arteries, where it becomes even more diluted; and in the final course of the *aorta,* giving rise to many extremely liquid fluids, it becomes denser again, and therefore throughout the system of this major artery, arterial blood is more fluid than venal.

340. — It follows from these remarks that blood is not the same in all vessels of living the bodies and, indeed, running from one to the other, it changes and acquires new properties. Not all of these transformations are yet well known, but the most important among them is the one which takes place between arterial and venous blood that we now ought to look into in greater detail. Since the most important organ in this transformation are the lungs, where blood comes into contact with air, and that happens through breathing; so consideration of how the arterial blood is elaborated leads us essentially to breathing.

CHAPTER XXII

ELABORATION OF ARTERIAL BLOOD. THE LUNGS. BREATHING.

341. — Transforming venous into arterial blood is an inevitable condition for maintaining its circulation and, therefore, life. *Goodwyn's* experiments have shown that black blood in the veins in the *aortic* system and in the pulmonary arteries, if it reaches the pulmonary veins and left ventricle of the heart unchanged, it will prevent movement of the heart, whose nature is such that only arterial blood can instigate its contractions. Once the heart stops to discharge blood and cast it into the *aorta,* it stops the circulation altogether, first in the branches of this huge artery, and then throughout the body. To keep blood circulation uninterrupted, it is necessary to perpetually process venous blood into arterial blood. Black and dense blood, characteristic of the venous flow, is so until the very end of the pulmonary arteries, and in the beginning of veins in the lungs we find it reddish, warmer, more fluent and slightly foamed; in a word, such which we call *arterial.* The entire transformation must, therefore, take place in the very passage from the arteries to pulmonary veins.

342. — The *lungs* are a very spongy internal organ, composed not only from numerous blood vessels,[40] cellular membrane, lymphatic vessels and nodes but, what is the most important, branches of the air duct. This duct, which is largely cartilaginous and strongly resilient, opens in the throat with a narrow aperture which leads to the cavity of the larynx composed of several cartilage and muscular folds, constituting part of the airway tube and being the most important voice organ. This tube, which consists of circular segments of cartilage, connected to each other and complemented by flesh fibres, is coated inside with a very sensitive film derived from the film surrounding the mouth, which is the extension of the skin. It is divided into two branches, one of which branches off further in the right lung, the other in the left. The divisions are similar to the way the arteries divide, into ever finer branches, reaching the most distant areas of each lung and ending with interconnected alveoli, around which the last capillaries of the arteries are twisted, as well as the beginnings of pulmonary veins, so that the air entering the lungs is separated from blood by the thinnest of membranes of those vessels. This separation does not prevent the blood from acting upon the air; it is as if the blood

40 That blood vessels are abundant in the lungs, it is easy to observe, considering that the entire artery emerging from the right cavity of the heart, separates in this cavity and is an origin of numerous veins which enter the left atrium in four branches. In addition, the lungs receive separate *arteries* also from the aortic system supplying arterial blood to maintain the same mass of renewal.

was directly in contact with it. *Priestley*'s experiments have shown that venous blood even when closed in a thick, moist follicle, impacts the air and experiences such changes influenced by the air as if it were directly spilled in it.

343. — The chest cavity is built in this manner that, while secured by bone walls providing safe habitat for the inner organs situated between them, these walls are quite mobile and ensure alternating expansion and tightening. The mobility of the walls depends in part on the modest mobility of the ribs themselves, pulled by the contractions of the intercostal muscles, but most importantly, by the movement of the diaphragm. The *diaphragm* is a large and strong membrane, partly composed of tendons, located transversely between the pulmonary and abdominal cavities, and extending from the bridge bone and the last six ribs to the lumbar vertebrae. This round, or rather oval membrane, is a kind of vault whose convexity is turned towards the chest cavity. Its entire centre is sinewy, and the muscle fibres coming out of it spread like rays towards the bone walls into which they grow. From such a composition of the diaphragm it follows that this muscular membrane, while contracting, must significantly lower its tendon and middle part, thereby increasing the entire chest cavity while pressing on the abdominal cavity at the same time.

344. — The chest cavity built in this manner expands and compresses alternately. This expansion and compression is a necessary resultant of the most unpleasant sensation

threatening utter destruction of each *individual* being in which the circulation of blood should completely cease. It would have to cease at this point in time in which arterial blood ceased to be elaborated (341) which in the born human can be elaborated only in the lungs. Thus, this awkward feeling compels the newborn baby to expand the chest cavity and then to immediately compress it. What, once begins, must endure throughout the whole life because life heavily depends on it.

345. — The lungs themselves, formed largely by branching of the bronchioles, are undoubtedly capable of compressing and expanding. Indeed, experiments show that, except for the air itself, any other body that touches the inner surface of the airway immediately stimulates the entire lung to strong and violent shrinkage. Hence, in addition to muscles belonging to the walls of the chest cavity, capable of expanding or compressing, the lungs themselves can draw air in and drive it out again. Any alien body irritating the inner surface of the lungs stimulates not only this internal organ, but also all the muscles forming the thoracic and abdominal walls to contraction and convulsions.

346. — Each enlargement of the chest cavity inevitably increases its volume; then the external air, due to the reduced resistance, is drawn through the air duct and expands the lungs: the compression following immediately after, again drives out a part of the air. Such alterations, happening perpetually one after another, are called *breathing*. Breathing consists of taking the breath in (*inspiratio*) and breathing

the air out (*exspiratio*). And because we breathe continuously throughout our lives, therefore, the lungs have been compared to bellows that, alternately, swell with air and expel it violently. Thanks to this, the blood circulating through the lungs touches fresh air with each breath: and this is also a vitally important condition of life.

347. — The animals can not breathe always one and the same air, they need constant replacement: it is because the air they breathe out is not fit for further breathing. Hence, if they are enclosed within a certain volume of either air or oxygen, not only does this volume decrease visibly due to breathing, but even within a short time they will suffocate completely. Analysing the gases remaining after such breathing we find a reduced amount of oxygen and an increased amount of carbonic acid. Similarly, enclosing black blood freshly drawn from the veins in a glass vessel filled with air or oxygen, we will see the decreasing volume of air, and after the interaction has been completed, we will notice a decrease in oxygen and increase in carbonic acid. Animals can not breathe anymore with the air so decomposed by blood. During this operation, black blood slowly becomes lighter and finally takes on beautiful bright red colour, characteristic of arterial blood. From these experiments we learn that black blood, which flows from the right atrium of the heart through the arteries and reaches the lungs, acts in the same way, through the vascular membranes, on the air which is breathed in, reducing the amount of oxygen in it and increasing the amount of carbonic acid, it is processed

from black venous to arterial red blood, with the only difference, namely, what happens slowly in the blood drawn from the vessels, happens instantaneously in the living circulating blood, broken into smallest particles in the tiniest branches of the vessels.

348. — Because this blood transformation can neither occur in the glass vessels from which the air is drawn nor in any gas deprived of oxygen; because oxygen containing acid is decomposed in its course and carbonic acid is produced; therefore, it should depend on the mutual effect of blood and oxygen, namely on the burning of coal. *Lavoisier,* however, counting the volume of carbonic acid formed by breathing and the amount of oxygen found in it, learned that only four fifths of the decomposed oxygen is to be found in the formed carbonic acid, thus, one fifth must either enter the bloodstream or be employed in forming water. Notwithstanding the fact that the absorbed air contains a lot of water vapour, which can not originate from another source; the following experiments prove that hydrogen in black blood merges with oxygen from the atmosphere.

349. — When bright red arterial blood is closed in hydrogen, its amount constantly decreases and blood turns blacker. Blackened in this manner, when transferred into oxygen, the latter decreases in volume and blood brightens in colour. These experiments teach that the cause of black venous blood color is that this blood contains more hydrogen which goes away by combining with atmospheric oxygen, then blood turns to arterial and water forms. Therefore,

black blood in contact with air loses altogether hydrogen and carbon, or hydrogenated carbon which, combining with atmospheric oxygen, gives rise to carbonic acid and water, and so blood becomes brighter and changes into arterial. In short, the essential difference between arterial and venous blood is in hydrogenated carbon, with which the latter is burdened. Whether or not something else enters the blood and combines with oxygen, the thing is not yet resolved: though there are many who believe that the blood itself assimilates a part of this element in the lungs; what especially is the belief of those who attribute red colour of blood to iron phosphate, thinking that the assimilated oxygen intensifies the colour. But even if this was so, taking into account small amounts of phosphate in the blood, and even more so, infinitely small amount coming in with chyle and entering the lungs with venous blood, it follows that the amount of oxygen entering in such a composition would be insignificant and in no way could it be noticed in experiments. The conviction of some Chemists that whole oxygen enters the blood, and merges with hydrogenated carbon only in the course of circulation has neither experimentally been proven nor has any reflection in the truth.

350. — According to this science one might think that oxygen in the air is only needed to breathe and elaborate arterial blood; and that the cleaner it is, the more oxygen it contains. But later experiments conducted by *Mr. Davy* lead us to different conclusions. With every breath he took, he inhaled 13 cubic inches of air; which consisted of the following:

Nitrogen 9.5.

Oxygen 3.4.

Carbonic acid 0.1.

With every breath he exhaled 12. 7 cubic inches of air consisting of:

Nitrogen 9.3.

Oxygen 2.2.

Carbonic acid 1.2.

He breathed 26 or 27 times per minute, so he digested during this time 31.6 cubic inches of oxygen and 5.2 cubic inches of nitrogen; he elaborated 26.6 cubic inches of carbonic acid.

351. — From this one and many other similar experiences it is obvious that during the transformation of venous into arterial blood, a certain part of nitrogen is undoubtedly connected to it. Not only oxygen, as previously understood, but also nitrogen inevitably is needed in the breathing of animals. The same author, in experiments on himself and on animals, understood that by breathing pure oxygen one digests six inches less of that gas per minute and produces 30 inches less carbonic acid than while breathing with ordinary air. Although this last case may only depend on the dilution of oxygen in the air; but it teaches us that the opinion of older Chemists and Physiologists who used to say that oxygen was better for breathing than atmospheric air, indeed, that gas should also be categorised as unbreathable, and that only air is capable of sustaining our life and our health in its entirety.

352. — This, and many similar experiments show that the black blood which we find in the veins of the aortic system, having been completely organically elaborated, is also burdened with hydrogenated carbon and because of fresh introduction of chyle and lymph, it is mixed with insufficiently animalised matter. But, in contact with air in the lungs, not only does it dispose of this excess hydrogenated carbon and increase the ratio of nitrogen, but it assimilates even a part of this element and, consequently, acquiring more powerful animal properties it becomes capable of supporting all the elaborations. Breathing, therefore, is an important activity for elaborating arterial blood; because all further organic elaborations depend on it; therefore, it is an important source and condition of all animal elaboration or *animalisation*. When the breathing stops, at this moment elaboration of arterial blood stops, as well as the movement of the left heart and blood and, thus, life. But even if contractions of the left heart could continue, then, because only the arterial blood can keep the course of life of the organs and of every living particle alive by supplying them matter capable of elaboration, this process would have to immediately cease throughout the body. So, the movement of life and the blood flow in the last branches of the *aorta* would cease, and thus movement in the trunk itself, and then in the left heart would have to cease. So our life, attached to arterial blood elaboration which can only form through breathing, is thus tied to an unbroken relationship with the air, as an essential

element of our whole existence, in which the inconceivable author of all things has perpetually plunged us.[41]

41 Recent experiments of French Physiologists showing that following the cutting or tying up the eighth pair of nerves, the chemical process slowly decreases in the lungs, and animal caloric slightly drops which proves, in my opinion, only that much: the lungs may be paralyzed thus their function suf-fers, moreover that their nerve life depends essentially on the eighth pair of nerves. The first truth did not even need experiments on the lungs but it could be useful in the practice of Medicine. The second is equally important for Physiology as it is for Medicine.

CHAPTER XXIII

FURTHER CIRCULATION OF BLOOD. TRANSFORMATION OF ARTERIAL INTO VENAL BLOOD. ANIMAL CALORIC.

353. — The black blood coming out of the right cavity of the heart is such until the end of the pulmonary arteries, and only in the veins it turns bright red; so the latter, brought by the four trunks of pulmonary veins to the atrium of the left heart and cast by the heart to the *aorta* is bright red down to the smallest branches and extreme ends of this great artery. Similarly to the way the venous blood is converted to arterial by contact with air, and in the very passage from pulmonary arteries to the veins, it becomes venous again following the contact with points of the organisation when it passes from the extreme ends of the *aorta* to the corresponding beginnings of veins. The blood circulation can thus be divided into two circulation systems: *large* circulation in which blood runs throughout the whole body, or the whole system of the *aorta*, and which begins with the arterial blood and ends in the venous; or *small*, that is, circulation through the lungs, which begins with venous blood and ends with arterial. The objective of the first circulation is to keep all animal

elaborations all over the body, and to supply, so to speak, an incentive to live to all points of the organized matter; the objective of the second is to refresh this blood and restore its original viable power by grasping this incentive from the air. This last transformation happens, as we know, by the contact of venous blood with air, and by the removal of hydrogenated carbon and the acquisition of nitrogen; so the first transformation, in contrast of the latter, must be done in reversal: the blood being transformed from arterial to venous must dispose of nitrogen, and become enriched with hydrogenated carbon.

354. — Foods, providing us with viable matter which is to undergo transformation in our bodies, are either purely vegetable or purely animal or, finally, may consist of both. In the first case, they have little nitrogen and a lot of carbon, hydrogen and oxygen; in the second and third, they have more nitrogen and less nitrogen. If they do not have any or very little of this element, they can not transform into real animal combinations unless they assimilate more or less of it to its composition. In the animals living only on plants, of course, this simple case is does take place; in other beings the animal elaboration must always go further, therefore, that case resembles the first. Although all animal juices in which foods dissolve, containing nitrogen, must share a part of it, so that every elaboration, every animal assimilation will signify a corresponding increase of nitrogen. But since these juices themselves are elaborated from blood, the process will always have to go back to the source

from which this common fluid draws nitrogen, therefore to air and breathing. For this reason, the most important organ for elaboration, and thus animal life, will be the lungs, and arterial blood will always be richer in nitrogen than venous blood.

355. — Animal parts in general, as for the nature of the elements they are made of, differ from the plants in that they contain nitrogen, more hydrogen, and far less carbon. The further animal elaboration proceeds, the more carbon should wane in the elaborated matter and more nitrogen and hydrogen should appear. Arterial blood elaboration is just such: a considerable amount of carbonic acid and little water vapour is formed from atmospheric oxygen. Thus, the significant loss of carbon itself increases the ratio of hydrogen to nitrogen among the remaining elements, but the prevalence must be on the part of the latter as more of it comes from the air in large amounts.

356. — And if any animal elaboration preceding the elaboration of arterial blood itself, if even the latter is connected with the arrival of nitrogen, other animal elaborations such as those pertaining nerve mass and muscles, similarly, can not take place without an increase in nitrogen rate. Taking into account the fact that all the animal parts are elaborated from arterial blood at the very ends of the *aorta*, so this proliferation of nitrogen must take place there. So, all the elements constituting the animal body, namely: hydrogen, carbon, oxygen and partly nitrogen enter the body with food in various organic combinations. These combinations, turning

into arterial blood, bring in more nitrogen and lose a significant proportion of carbon and some hydrogen, and in this way acquire stronger animal characteristics. Transforming then from blood to other organic parts, since animal elaboration continues in them, so in the exchange itself they must lose a significant proportion of carbon and a part of hydrogen, retaining more nitrogen. The blood, after such elaboration, must have a reduced amount of nitrogen and increased hydrocarbon, and this is the nature of the conversion of the arterial into venous blood. So what happens in the lungs with venous blood also happens at the very ends of the *aorta* with organizing parts: there, the animal nature of blood increases in the contact with the air, here the living parts in contact with arterial blood. But, on the other hand, what happens with the blood in the lungs dissipates at the ends of the *aorta* and, as its animal nature increases there, here it decreases. So, the elaboration of organic parts nourished by blood can be considered to be its dissipation. In short, we take all the elements that constitute us from food and drink and most of nitrogen from the air. Therefore, the less food the animal beings use, or the longer they refrain from food, the more the animal nature of their blood and solid parts shall increase.

357. — But these are not all differences between arterial and venous blood. Apart from the experiments proving former is slightly warmer than the latter. *Crawford*, in his witty and irrefutable experiments, has shown that the opportunity to absorb caloric is far greater in arterial than in

venous blood, with the ratio of the former to the latter at 11.5: 10. Consequently, arterial blood not only has more free caloric than venous blood, but also has a large part of latent caloric saturating its potential. This beautiful property is the most important difference. And because the arterial blood is elaborated in the lungs by disposing of carbon and partly hydrogen, and acquiring nitrogen, so it is easy to find the source from which it draws caloric saturating its increased potential. *Firstly,* because nitrogen entering the blood, therefore, transforming into a liquid and a rather dense one releases a great part of the combined caloric. *Secondly:* burning hydrogen and carbon must also extract a considerable proportion of caloric from oxygen. So, part of it enters into the carbon composition, and a small amount into water vapour, a part is used to saturate the increased arterial blood potential, while a part makes the inhaled air warmer and leaves free with the air. Thus, in the lungs, a large part of caloric enters arterial blood without raising its temperature; this is the amount which is yet to increase also because arterial blood is more fluent than venous and, hence, it must have more combined caloric than the latter.

358. — Due to the fact that, in the final capillaries of the *aorta,* arterial blood serving all animal elaborations and nourishing the organs it flows into, changes again into venous blood, thus returning again to its former density and potential, and therefore, the combined caloric saturating its potential leaves it. Every point of the living body receiving blood from the *aorta*, elaborating from it and renewing,

becomes simultaneously warmer. So, what amounts to the same thing, every organic elaboration is connected with proportional extraction of caloric and, therefore, an increase in temperature, or: *life and warming of matter are two inseparable events.*

359. — Thus, organic creatures which breathe extract caloric from the atmosphere and maintain body warmth thanks to the circulation of blood which ensures organic elaboration and life at every point. So, extraction of caloric, or rather warming the body, depending at all times on organic processes and the course of life, must altogether be in a simple relationship with those two. And, since experience shows that animal body temperature, at least in health, is steadily the same, so it must be considered in two aspects: firstly as emerging, i.e., being born, secondly, assimilated and fading at the same ratio. It is because only a complete equality of these two processes can maintain the uniformity of temperature, so the process of cooling must not only correspond to the process of warming in the entire animal economy, it must be balanced at all times. We ought to, therefore, identify this process, too.

360. — Those who had imagined the lungs to be a fireplace heating the whole animal structure considered the skin to be a cooling device, through which animals disposed of unnecessary and unpleasant heat. Consequently, according to their assumption, *transpiration,* i.e., the discharge of gases and invisible water vapour on the surface of the body was the most effective and sufficient way of disposing

of caloric, especially since the air itself, usually cooler than body temperature, perpetually cools the skin and the blood that flows through it. Such reduction of the animal heat can be conceived on the surface of the body but, concerning the inner organs, it can neither be understood nor interpreted in this manner. Neither can this interpretation be applied to the outer surface when the ambient air temperature equals or exceeds ours. This, however, happens fairly often. In addition, because we understand that the release and flow of caloric takes place at all points reached by the arterial blood, and at any given moment, so also at all these points and at any moment this caloric must be consumed and perish. Because, according to the universal laws of the organic economy, what is elaborated on the one hand, on the other hand is dissipated at the same rate; and this the balance of function of the living beings and their whole existence depends on it.

361. — In my view, and far more universal in application, will be the following primary assumption: *at every living point two opposing processes occur perpetually*, namely: organic elaboration and dissipation; *therefore the warmth generated,* as we have seen, *in the first of these processes must be destroyed in the other.* In organic elaboration the formation of gases can only take place on the outer surface of the skin and the inner surface of the lungs, and the elaboration itself — everywhere. The most important known organ of elaboration is the system of lymphatic vessels whose action consists in collecting, at every point, the organic matter

being elaborated, and transporting it to the general mass of juices. And since solids can not be assimilated by lymphatic vessels otherwise but in the liquid form, or at least they are not found in the vessels in a different form, therefore, every elaboration is connected with a dissolution of solids and, hence, with assimilating and introducing a large proportion of caloric to the combination. Prompted by this consideration, I regard lymphatic vessels to be the most important organs designated to cooling the living parts. Finally, as we have learned through experiments, an almost complete mystery of animal warming is encapsulated the ratio of potential of arterial to venous blood; similarly, learning about a similar lymph ratio, if it is ever be possible, may reveal the entire mystery of the waning warmth.[42] Thus, dissolved elements enter the blood, most of them having already lost their viability; they become material of the faeces, and carry the veiled caloric beyond the limits of the body. And for that reason, the excessive measure of warmth is immediately followed by increase of the faeces, leading to new and unusual dejecta, namely sweat.

362. — Organic beings generally generate their own heat, their specific body temperature, generally independent from ambient temperature. Red-blooded animals that

42 Even the beginnings of veins, taking in the separated hydrocarbon, remaining after the elaboration of organs as material of excretion which the blood disposes of in the lungs seem to partly belong to organic elaboration and therefore, they can be part of cooling, although the knowledge we have today does not allow us to find out how.

breathe generate far more heat; their body temperature is quite high and is even less affected by the ambient temperature. Body temperature of a healthy person is close to 32° *Réaumur*, and is the same in summer heat as strong frosts, in *individuals* living on the equator or near the poles of the Earth. In Western India, often the temperature of the air equalizes the warmth of human blood and in Senegal at 17 degrees latitude, almost steadily surpassing it; however, the inhabitants of these countries are quite healthy. In our country, the temperature in cottages is often 33° or 34° *Réaumur*; therefore, we do not see that this superfluous temperature should harm the peasants. Charles *Blagden*, experimenting what level of temperature a human can bear with no detriment to health, sat in the oven with a temperature little lower than the temperature of boiling water. He, nonetheless, withstood this extreme heat unharmed, sweating only abundantly and drinking a lot.

363. — So, with every rise in the outside temperature we see following abundant sweat which is commonly regarded to be a way of reducing temperature and maintaining internal temperature in a decent balance, judging by the fact that increased evaporation on the surface of the skin takes a lot of caloric. Considering the thing closer it follows that: invisible fumes, that is, in the state of gas and invisible water vapour, should assimilate far more caloric than sweat. Does this invisible transpiration increase under the influence of external heat or not? This is not known, but sweat is rather an unusual discharge, showing increased dissipation of

organic matter and plentiful elaboration of water. This perception should have taught us that animals have the power to produce water (108) just as plants do, using to this end hydrogen and oxygen clotted in their organs, and that process is as cooling as it is in the latter.[43] They dispose of most of this water through the skin and the lungs which produce and exude the more water vapour, the higher the outside temperature. Hence, at high temperatures, not only the skin but also the lungs become important cooling organs. Hence, the need for abundant drink, partly as a swift replacement of vapour with water into, and partly to compensate the losses of hydrogen and oxygen, and to maintain the balance of elements constituting in the composition of organic matter. This ability of living creatures to produce vapour and volatile substances from solids or liquids in higher temperature,

43 Plants elaborate oxygen and water vapour, and thus dispose of internal heat in the same ratio as they release it in organic elaboration (109). With the increase of external heat this cooling process intensifies, too. We can see, of course, that with regard to the formation of water vapour, the cooling process is the same in animals as in plants. It can not be doubted that the animals decompose water just like plants do. The only question remains whether they also exude oxygen? This thought has never employed anyone and has not led to a certain range of experiment. With all this, it may be quite true that because plants decompose so much oxygen on the one hand as they produce it on the other, and thus they not affect the replacement of oxygen in the air; similarly, animals must behave in a similar mover with respect to atmosphere. But such a thought can only be only confirmed or contradicted by experiments.

and thus introducing caloric to the composition of the combination, is so great that when staying for extended periods of time in an excessively hot place they are not only capable of retaining their own temperature but even reduce superfluous heat of that place, as proved by indisputable experiments, but, as we know from the everyday experience, they can heat places which are too cold.

364. — On the contrary, where the temperature is significantly lower than the animal body temperature, e.g., zero or below zero, the skin is completely dry and all visible discharge ceases. Only one, that of the urine, is rich enough for reasons that will be explained below. So in this case, the formation of water vapour is reduced or halted, while the air is inhaled and assimilated more abundantly, and thus more caloric is extracted from it. The primary reason for maintaining the internal temperature independent of ambient temperature may be that the lower the latter is, the more abundantly and much better arterial blood is elaborated, and therefore, at the given time it absorbs more caloric in the lungs,[44] and during circulation it releases more of it in

44 With increasing cold, we try to intensify and accelerate the circulation of blood, being the only source of warmth. This is done thanks to intensified activity of muscles. Hence running, skipping, slapping and rubbing hands and legs in the winter. Henceforward, the most abundant source of animal heat is the elaboration of muscles, and because it is the most animalised part of the animal we can see yet again that the stronger animal elaboration, the more abundant emanation of caloric. This also explains why northern peoples have most powerful muscles.

the branches of the *aorta*: the higher the less: it can not happen otherwise, because the blood absorbs more nitrogen in the cold air, while in the warm very little or none at all. This matter ought to be decided experimentally. Hence, it follows that *animal elaboration* (*animalisatio*) *should be far stronger in the cold, just like plant elaboration* (*vegetatio*) *in the warm environment.*

365. — It would inevitably follow from such an assumption be necessary that the power of animal elaboration should be in every case *at a simple ratio to internal temperature*, and therefore that in different genera and species this ratio could be a measure of the power of elaboration. Experiments show us that the birds, whose temperature is highest, have the strongest muscles, and fish the weakest. Hence, it follows hydrocarbon is collected in the body, the weaker the animalisation; oil is the richest source of hydrocarbon, so obesity should be a sign of poor animal elaboration and, therefore, imperfect lung function. Hence the skinny ones, in whom animal elaboration is sturdy, should feel better in summer and obese ones in winter. Due to the fact that degree of temperature in breathing animals varies, it depends on their position in the chain of organic beings, and on the particular structure of the lungs as well as the system of blood vessels.

366. — In illness, the rise or fall of temperature above or below the normal degree is generally attributed by the more recent authors either to reduction of the cooling process without a corresponding heating loss without equal

increase in cooling, and vice versa. But this explanation is obviously wrong: if such an imbalance should ever take place, the living body should either warm up until it glows and burns, or would have to cool down until it is stone cold; neither case has yet been recorded, unless we account for rare examples of voluntary incineration of living bodies. It, therefore, follows that no other reason may be attributed to accidental and transient increase or decrease in temperature save for acceleration or deceleration of the life course, and thus, fast or slow rate of heating and cooling processes. The animal body which generates a lot of heat, returning it at the same rate, must seem hot to all those who do not generate so much of it and cold to those who generate more of it; but remembering that the body presents a relatively stable temperature, as we see in fevers, it must be admitted that the cooling process is perfectly balanced with the heating process. Moreover, experience itself shows that the rise or fall of ordinary temperature is only strong with respect to senses: thermometers show barely three or four degrees of elevation in the most violent fevers.

CHAPTER XXIV

ASSIMILATION OF BLOOD. ELABORATION OF PERMANENT PARTS OR NURTURING (*nutritio*).

367. — Animal assimilation and elaboration does not end with the elaboration of blood, which is merely the material and object of all further elaboration and, therefore, the source of the most important apparitions of life. Hence, its great importance with former physicians and the primary consideration in explaining the events of animal economy so carelessly dismissed in later times. Blood reaches, via the final aortic branches, all the living parts; indeed, it attains all points of living matter as such, or sends a particle separated from itself. These parts, according to the established assumptions and the laws of life, have to be permanently elaborated and renewed, and viable matter can only reach them by means of blood circulation. Therefore, those parts, directly or indirectly, can not be elaborated otherwise but from arterial blood. It must be a source of elaboration for muscles, nerves, membranes, vessels, bones, cartilage, etc., taking in blood completely or partially and transforming into itself according to the same original assumptions and laws by which nourishing

foods are the source of elaboration for chyle and, subsequently, for blood. It is impossible to understand the manner of those activities, but in many cases, their conditions and rights can be determined; it is possible, basing on accurate knowledge and analysis of specific organs to guess and conclude which of the elements originate mostly from blood or into which blood is transformed. Each part must either completely transform blood into itself, or separate from it and process some elements reject and other. For example, bones must either take or elaborate from blood phosphate and calcium carbonate; muscles must, essentially, elaborate fibre because among all other organic parts they contain nitrogen, they must absorb the most of this element and thus be the most important vehicle of releasing caloric, etc.

368. — Physiologists usually explain the feeding of organic parts by adherence, i.e., the *appositio* of particles of the same kind. Such an explanation, however, is mechanical and basic, moreover it is completely arbitrary because 1) it is based on the assumption that all organic parts are already ready in the blood: and this assumption is false when it can be just as well to say that blood is already ready in bread: what can only be true in poetry. 2) In the strict sense, growth can be understood by the adhesion and the gathering of particles, although these must first be elaborated; but properly understood *nutrition must be the true replacement*. Thus, the concept imagery of *nutrition* (*nutritio*) is necessarily composed of organic elaboration and dissipation, and this

is the main difference from *secretion* which, in most part, is constant elaboration.

369. — The physiological assumption is equally arbitrary: that nutrition is the ultimate and most perfect form of all organic elaborations. After all, the elaborated parts are again dissipated, assimilated by lymphatic vessels and returned to the blood where, if they have not attained the highest degree of animal elaboration, they can be further *animalised* and turned to food for better elaborated parts. Ultimately, some organic parts are viable for other parts and can not be transformed into them. And so, the entire cellular membrane, all membranes and tendons made almost entirely of jelly; when they have melted and enter lymphatic vessels in a liquid state or from lymphatic vessels into blood, they can continue the elaboration and transform into protein and, further transforming, into fibre. In short, in the same *individual,* some organic parts can serve as food for others, just like some genera and species of living beings become food and a way to sustain others.

370. — Although Physiologists have presumed the renewal of organic parts, but analysing the science in this respect it becomes evident that they had no real idea about it; they neither considered the renewal to be true nutrition, commonly regarding the latter to be growth or living organs putting on weight. Some even wanted to determine and limit the time of this renewal and defined seven years as a period of renewal of the whole body. The assumption is also arbitrary and proves that their concepts and representations

were quite erroneous. This renewal, as a matter of fact, is both imperceptible and, at least in many living parts, must be infinitely faster; as we often see the changing form, composition, colour and activity of the body or some organs in a very short time. Indeed, this change is necessarily continuous and incessant, because warmth, animal life and the whole existence of organized beings depends on it. But the time of this change in *individuals* or organs, of course, must be different in various genera and species depending, so to speak, on the type of the course of life and its rate; thus, basing on experiments performed on a single organ or a single *individual,* this judgement can not be applied to others or, strictly speaking, experiments in this respect can not be generalised. Indeed, in the same *individuals* and organs, everything that affects the speed of the course of life must also influence the rate of renewal; hence the nature of food needing longer or shorter time to be assimilated, type of work or rest, ambient temperature, age, sex, temperament and climate. Furthermore, different rate of renewal may be one of the important causes for the difference between one organ and another; these which are renewed faster have proportionately more blood and lymphatic vessels, so that from this relative amount of vessels it would be possible to judge quite well the various rates of their course of life.

371. — The most important thing, considering nutrition of living parts, is to distinguish between renewal and gain, that is, growth, although one and the other is a true assimilation. *Nonetheless, the first one is almost at the opposite rate*

to the other, because *renewal is the more rapid the faster is the course of life, and gain and growth the slower.* That is why young animals grow much faster in their sleep than during the waking hours, similarly, as experiment has shown, it is believed that the plants grow much better at night than in the day. Therefore, maturation and obesity are in a simple relationship to comfort and rest, while complete elaboration, power of the course of life and the force that depends on it, are in a reverse relationship. As it follows from the preceding teachings: *the smaller the mass on which elaboration is concentrated, the more intense it becomes; the more it effuses the weaker it becomes.* We may, therefore, conclude that *the causes fostering such effusion are the weakening causes.*

CHAPTER XXV

SECRETIONS.

372. — Secretion is a category of organic elaboration by which, in follicles and nodes serving that purpose or in similar organs, fluids of particular properties are produced from blood. And because these fluids are elaborated from blood, so the history of all secretions and fluids they have elaborated must follow the history of blood itself. The desire to present the theory of secretions, which Physiologists had strived for so long is the same as wanting to understand and explain any organic elaboration; therefore, no one shall expect the perfect explanation of these organic activities as to the way they develop. It seems to us that we are not far from the truth when we say that the liquids already elaborated, found in the nodes and follicles, and help to create new ones, similar ones, exerting absorption power on blood which, as we know, is far stronger in fluids than in solid parts (139).[45]

373. — More ancient Physiologists understood that all the juices elaborated from blood were to be found ready

45 The comment about this perception is the following: if the elaborated fluids help to elaborate similar ones, then it could not have happened in their original creation; nonetheless the original creation can not be presented or explained, and this is what it really boils down to.

made in the blood itself, and that those juices only separated in the organs serving that purpose, and that the separation took place in accordance to different apertures, lengths and twists of vessels through which only those and no other juices could pass. However, such a mechanical explanation, based on the consideration of animal fluids to be spheres of various sizes, collapses when confronted with very thorough knowledge of blood which does not contain either saliva, chyle or bile or urine, etc., In addition, the explication of the difference in animal fluids by the various sizes of spheres will not be attractive to anyone today. Nevertheless, there are much more fortunate explanations offered by those who derive all the transformations of animal fluids only from the changed activity of the solid parts. True, that these parts themselves are elaborated from liquids, and do originate in liquids because, if they were to signify the nature of the liquids they contain, they should be non-transformable and should not depend on those fluids at all; while in the organic economy the same animated elements which have only just become liquid, turn into solids, and the solid ones dissolve again perpetually. Therefore, the activity is not only necessarily reciprocal, but probably balanced, too.

374. — The state of secretion sometimes changes, either within the change of the state of the entire machine or of the organ of secretion, namely alongside with the change of the rate of the course of life, internal temperature, and the function of nerves which reach all the organs of secretion and seem to play a significant role in that organic activity. Even

the condition of blood must necessarily affect the secretion, as well as the nature of the food influencing the condition of blood and the rate of the course of life. These changes in organic liquids, however, are enclosed within certain limits; one liquid loses its intrinsic properties but does not turn into another. Bile, for example, is sometimes yellow, green or black, dense or watery very or not at all bitter, but it never ceases to be bile, never loses its true characteristics, and never turns into semen or chyle. The same should be maintained about all other juices. In what manner these juices transpire in illness, we shall see elsewhere.

375. — We can divide fluids elaborated from blood into those which serve to assimilate and further elaborate viable matter arriving from the outside and which, returning, partially or completely merge with blood; and into those that have to be expelled from the body as beings that can not any further be an object of organic elaboration because they have lost all viability with respect to that particular living creature. Even the former, not refreshed and untransformed by new viable matter, can not return to blood on their own; and if they do not have new matter to process, they ought to be expelled. These include: saliva, gastric juice, pancreatic juice and bile which all serve digestion; those also include the male semen and chyle, which elaborate only in some periods of time and have their own predestination. Animal fluids, elaborated and enclosed in the cavities of the body, have no other way of exit save for entering the lymphatic system together with the dissolved solid parts, and transforming

into lymph. Such can still serve for further elaborations and are, in a manner of speaking, a store of viable matter which the blood and other organic parts can use to refresh from time to time. Purely excremental elaborations include urine and the gut excrement.

CHAPTER XXVI

ANIMAL JUICES SERVING DIGESTION.

376. — *Saliva*. The first juice which is mixed with food and begins the animal assimilation is saliva. This fluid is elaborated in six glands located around the mouth cavity, where it flows via ducts, separately from each gland. The action of the chewing muscles increases the flow of saliva to the mouth, while the muscles seem to press on the glands and squeeze the juice out, already elaborated and ready. In the same way, the very presence of food in the mouth or its representation or memory of the favourite food increases the elaboration and inflow of this fluid. It is watery and slightly sticky; it foams with every move, very easily swallows the air which seems to merge with it when food is chewed. It is almost completely tasteless and odourless, and without any alkaline characteristics which are common in watery animal fluids. Its property of receiving airborne oxygen and sharing it with other bodies may be important in digesting food. Chemical breakdown shows the content of animal mucilage, as well as kitchen salt, sodium phosphate, calcium phosphate and ammonium phosphate.

377. — Although this liquid is sometimes expelled in large quantities, it is not intended to be disposed of: it is the

first and essential juice for dissolving foods. It is fluent and watery so that dissolving is smoother and food better prepared further organic elaboration. In addition to saliva, the entire inner surface of the mouth is moisturised with a kind of mucus which is elaborated by follicles scattered throughout the surface of the mouth and on the tongue; but which does not seem to serve digestion, although in the course of chewing and swallowing it obviously mixes with saliva and food. The most important among these glands are so called *tonsils*, embedded between the folds of the soft palate. Physiologists understand that this mucus, moisturising the throat and mouth, is designed to wrap around hard, dry, and heavy foods so that they could pass through the throat with ease.

378. — *Gastric juice.* Nowadays, no other animal juice employs so many Naturalists, Physiologists and Chemists as so-called *gastric juice* (*succus gastricus*). *Réaumur's* and *Spallanzani's* experiments proving its dissolving properties have drawn the attention of everyone, although strictly speaking, those dissolving and assimilating properties are not only a characteristic of gastric juice but for all organic liquids. The remarkable surprise, which this property of the gastric juice had sprung among scientists, was the strongest evidence of a poor knowledge of the general laws of animal economy. Nonetheless, the scientists were unable to find, at least not in the human stomach, the glands which would elaborate this kind of juice; but little they wondered — it was enough for them to state that those glands were quite

visible in the stomachs of birds so, presumably, they must be found in other stomachs, too. It seems that nature, whose the ways are always closely bound to its intentions, should not have neglected to create an organ corresponding to the importance of the thing if the whole work of digestion had been entrusted to the so called gastric juice. This remark should be supplemented by the assertion that, if what we are to call the stomach juice, as the authors writing about it do, is a small amount of fluid extracted from an empty stomach, then it is necessary to consider the fact that various other juices, such as saliva which we continually swallow, flow down into that internal organ.

379. — For such and similar reasons I understand that the juice that is exuded, in very small, indeed nearly insignificant amount, from the inner surface of the stomach has been attributed excessive importance; too little attention has been paid to the saliva which, perfectly mixed in the mouth, and with a large amount of food, flows down to the stomach; where it has time, assistance, and proper temperature to dissolve food perfectly and transform into stomach chyle. The nature of saliva, the size of the glands where it is elaborated, its abundant flow during food consumption or at the sight or memory of them; improbability of noticing glands which would elaborate gastric juice, and hence, the uncertainty of a separate existence of this kind of juice, its scarcity, and always different amounts of this juice in the stomach; all this speaks for this belief. After all, the moisture on the sides of the stomach may help this labour, but

its amount is too insignificant to be able to do it on its own. Finally, to support this belief, this argument may also serve us well, that chyle, thick and imperfectly dissolved, formed in the stomach after the first digestion, dissolves further and elaborates with the help of pancreatic juice, which very much resembles saliva.

380. — *Pancreatic juice*. The first part of the digestive tract, to which the thick chyle elaborated in the stomach flows, is called the *twelve finger intestine* (*duodenum*). The two juices of major importance in the animal economy pour into it: pancreatic juice and bile. The first is elaborated in an extensive gland, and its form as well as composition is quite similar to saliva. And though its deep and hidden location makes all access in living animals difficult, and without killing them, almost unlikely. Although in the duodenum itself, it is impossible to collect this juice as it is mixed with bile, it was possible to gather it in quite large quantities. And so *Graaf*, having reached, in a living dog, as far as the duct through which pancreatic juice flows, tied this duct to a small flask, and after a few hours collected a significant amount of the juice in question. From the experiments, the knowledge which could have been gathered in the then state of knowledge showed so much that pancreatic juice was whitish and slightly salty, and in everything resembled saliva. Consequently, it must be assumed that its use must be the same, namely, to further and complete the digestion and dissolution of food which has begun in the stomach. For that reason the duodenum should be considered the second

stomach in which the dissolution of food, commenced in the first one, is brought to an end.

381. — *Bile.* Considering how extensive and important the internal organ is employed to elaborate bile; how nature has even dedicated a special system of blood vessels with this purpose; moreover, how other abdominal organs assist this purpose, one can not fail to admit that this juice must be of major significance in animal economy. The final elaboration and, so to speak, completion of chyle depends on this fluid, therefore it should be assigned the most important function in digestion and in initial assimilation of food. In all sucking mammals, the liver is not only directly intended for the elaboration of this juice, it is one of the internal organs with the most impressive size, but even receives a considerable amount of specific blood, as it seems, deliberately pre-prepared. And therefore, although bile is elaborated only in the liver, nonetheless there are other internal organs playing a role in preparation of this particular kind of blood flowing to that huge gland, therefore helping its elaboration. Consequently, they ought to be considered to be bile organs.

382. — All the veins supplying blood to the abdominal organs, namely to the spleen, the stomach and the fat the entire intestinal duct, accumulate under the liver and combine into one trunk, which expands, firstly, into a wider sack and assumes a fleshy nature and then transformed as if into an artery, divides like an artery into ever smaller and finer branches, and reaches all the follicles of the liver. There,

having been employed to elaborate bile which flows into its ducts, gives rise to the veins which gather in their usual order and transport the blood remaining after the elaboration of bile to the large vein (*vena cava*).

383. — In addition, the liver receives blood via small artery from the right branch of the *coeliacae,* which also spreads out over its entire mass, but the blood it supplies does not mix with the preceding, but flows into separate beginnings of veins and those, gathered into a single trunk, flow into a vein called *lonely* (*sine pari*) or to the vena cava. Supposedly, the blood serving bile elaboration is not fit to maintain the renewal and the temperature of the liver mass itself when this internal organ, just like the lungs, finally receives blood via a separate artery.

384. — It is evident from the above that the liver system is completely separate, with its own blood and circulation, and that some abdominal organs, namely the spleen and fat, are designed to prepare and elaborate blood for the liver circulation, just like the lungs prepare blood designed to maintain circulation in the *aortic* system. There are no experiments, however, or at least none of them have come to my knowledge, which would perfectly identify the nature of the blood, either in the liver vein itself or in the branches which merge to form it; such as, for example, we have identified the properties of arterial and venous blood. It is, after all, experiments that may elucidate the entire function of the liver and other abdominal organs. As to the spleen vein, we have only learned that the blood circulating in it, after leaving

this spongy organ, has the colour, fluidity and other properties of arterial blood, and even more so than in the arteries themselves. And since this vein is the most significant of all the branches of the hepatic vein, it seems that bile elaboration is consistent, at least with other animal elaborations, in this that it can not do without arterial blood.

385. — To the preceding point one could add the following: as one of the conditions of arterial blood elaboration is to dispose of a part of hydrocarbon, this condition may be satisfied by the fat in the fascia containing fat, which produces a significant amount of oily substances. Regardless of the fact that the blood of the spleen does not match arterial blood at all, each of the branches that make up the liver vein may contain special blood, dissimilar from any other; and all these blood types mixed together in a sack, where the distribution of liver vessels begins, must again give a new type of blood from which the bile itself is to be elaborated.

386. — What the Physiologists told us about the oily, alkaline, bitter, etc., nature of the liver blood was a pure conjecture, unsupported by experiment. We will not be able to develop a sound judgement about specific transformations which this blood undergoes in the preparatory organs, as well as in the liver itself, until experiments show us what exactly these blood differences are. What a beautiful and fertile new field of research, work and experience!

387. — The bile, elaborated at the very ends of the liver vein, drains into the openings of separate vessels, which converge in a manner of veins, and merge into a single duct

called the *liver bile duct*. In man and many animals, bile flowing through that duct may not always flow further into the intestines; it passes in twists between the membranes of the duodenum, and thus, it holds up whenever the bowel is not full or has sunk. The aforementioned duct is joined, at an acute angle, with another, emerging from a fairly large sack, called a gall bladder. From that system it is evident that, since the bile never ceases to be elaborated and, therefore, flows down its proper duct, so whenever it can not be drained to the bowel cavity, it must be collected and fills the gall bladder. If it is also full, and the passage to the bowels is completely blocked, the elaborated juice stops draining through the bile ducts and mixes with blood. It is a case of disease, given the name of jaundice by physicians.

388. — There is little known about the bile, elaborated in the liver, which flows through the bile duct straight into the bowels, because to separate and harvest it is very difficult. The one, however, which is found in the gall bladder, easy to collect, is quite well known. Nonetheless, we generally understand that the latter is no different from the first save for greater density from its longer residence in the gallbladder and, consequently, the loss of fluid parts taken over by the lymphatic vessels. There are some who consider liver bile to be pleasant and by no means bitter, understanding that the bitterness, proper for the gallbladder bile, is elaborated in a special gland placed between its membranes. In any case, this animal fluid is subject to many transformations, at different ages, in different seasons of the year, as well as in

various health conditions; some physicians, especially in the past, attributed to those transformations changes in health.

389. — The gallbladder bile is a dense, thickly and sticky juice, greenish or dark green in colour, and bitter in taste. Whipped up, it foams like soap and, indeed, it contains an animal combination of soda and a special oily substance that some wanted to consider resinous.[46] This soapy substance has merged the bile with protein so firmly to that it would not curd even under fire. These two parts essentially forming bile have an admixture of sodium chloride, and sodium phosphate lime and a little iron. Strong tendency of bile to rot shows its intense animal nature and teaches us that the food assimilated in the intestinal tract receives the strongest animal stigma from bile.

390. — Physiologists strived to explain the effect of bile on stomach chyle by bile's soapy nature, understanding that it facilitates merging oil fractions with watery ones, that it thins out those fractions, separating thicker parts and those hard to dissolve and, as a fairly sharp being, excites and keeps the movement of the gut active and, therefore, helps separating and colouring of the excrement. But, according to the laws and assumptions adopted by us, no organic activity can be explained in terms of simple mechanical or chemical assumptions, and bile mixed with pancreatic juice must act upon the thick gastric chyle according to the general

46 *See* [Sniadecki, Jedrzej.] *Poczatki Chemii*, [2 t., Wilno: Nakl. i dr. J. Zawadskiego, 1807] § 900–904.

laws of the animal economy, namely by their further animal elaboration, assimilation and dissolution. However, since a large proportion of the transformed bile is to be found in excrement, and gives it colour, it should be postulated that this juice is a large part of the excreta, and in some cases of disease it indeed becomes so, leaving the body through vomit and lax.

391. — Concluding the above, we can say that: 1) The duodenum is an important and essential area where chyle is elaborated and, therefore, excellent digestion. 2) That bile is most important fluid assisting this labour. 3) That the activity of abdominal organs and the effect on the formation of a particular type of blood circulating in the liver is not yet known. 4) That the nature of this blood and its impact on the general animal economy is also a real mystery. Finally, that bile is partly an excretional fluid. The chyle elaborated in the duodenum slowly flows through the entire course of the small intestine thin flask where it is sucked by the apertures of chyle vessels, perfect, process in the *mesenteries* and, mixed with the lymph, finally merge with blood.

CHAPTER XXVII

ELABORATION OF ANIMAL FAT. OBESITY.

392. — Fat, or animal oil, should occur between fluids separated from blood, because it is elaborated by specific follicles scattered here in the cell membrane, and is steadily fluid in the living bodies. However, the cellular membrane is not everywhere equipped with follicles separating fat, and they are not equally present everywhere; and that is why this oily fluid does not gather everywhere, and not in equal quantities. Just under the skin and around flesh it occurs in copious amounts, which gives the body certain softness, suppleness and roundness. However, we find its most generous representation around the kidneys, in the abdominal fascia called lard, around the heart, in the central compartment of the thoracic cavity (*mediastinum*) as well as around chest muscles and glands constituting the breast, especially in the female: what gives those organs protrusion and roundness. On the contrary, the brain and the surface of the head, especially the forehead, the nostrils, ears and the lungs are normally without fat. In the cells of riddled bones and in the cavities of long bones there is also a considerable amount of fat in, known by the name of marrow.

393. — Fat is not equally abundant in all animal species and, in the same species, not equally distributed in all *individuals,* not at all times, and at all ages. In the foetus, e.g., up to five months there is yet no trace of it. After birth, almost all babies put on quite a lot of weight, this infant obesity is lost again in childhood, in adult obesity peaks around the age of forty, and later, in the old age, it decreases and wanes. Calmness of mind, rest lent to the body and soul, long sleep, castration, abundant and easy-to-digest foods all lead to obesity. That is why people who are busy with a hard labour either of body or mind, with temperament leading to anxiety, diligent, caring, never put on weight. Similarly, those in whom the function of the generic system is strong do not put on weight, the castrated and invalids do; this is why by castration we dispose animals and birds on the farm to putting on a lot of weight. On the other hand, obesity itself is a proof of the weakness or inactivity of this system; therefore where we commonly see infertile obese women, and men and indolent obese men

394. — In general, everything that slows the course of life and blood circulation, what slows down the process of organic elaboration and dissipation, and therefore excreta, what reduces the loss of hydrocarbon, necessarily leads to obesity. And because we lose hydrogenated carbon, the material of oil, in the lungs where these elements are digested and transform into water and carbonic acid; it is this loss, combined with ingestion of nitrogen, that constitutes animal elaboration of food and blood, equal to the

exchange of venous into arterial blood; so *obesity, in every case, will in the reverse ratio to animal elaboration*. For this reason, given equal circumstances, plant foods — against common conviction — should help obesity and serve those losing weight, while animal food should be in opposition and serve the obese. Excessive obesity becomes a burden and is a real disease, therefore should find its place among illnesses.

395. — Animal fat, however, wherever it is taken from, has the nature of oils and, in general, differs from them only slightly, therefore, it should be considered only a barely elaborated combination, i.e., the least animalised. This combination, pumped by lymphatic vessels, processed and transferred to the blood, becomes a material of further elaboration and assimilation, and makes the deficiencies of viable foods temporarily passable. Therefore, cellular membrane can be considered as a storehouse where, during the abundance of food and poor animal elaboration, a surplus of viable and half-digested matter is collected and retained for further use: all the more that this sticky and slippery moisture is usually collected there in the state of liquid or vapour, filling cell membranes; furthermore, ingested by lymphatic vessels, it is one of the lymph materials and, therefore, building material of elements serving the renewal of blood.

CHAPTER XXVIII

ANIMAL EXCRETA AND THEIR ELABORATION.

396. — Excreta should also be considered as real animal elaborations, or *secretions,* because almost all of them, firstly, are elaborated in special glandular organs or those resembling glands, and they are held and stored in other organs until they have been expelled beyond the limits of the body. Urine, for example, is made in special organs having all the properties of glands; it then collects and is held for some time in, and only after the bladder has become completely full, it is discharged. Similarly, excrement is elaborated and stored for an extended period of time in the cavity of large intestine before it is expelled from the body. Only invisible vapours, known by the name of *transpiration,* do not seem to be retained and stored in any organ but, similarly to those exuded by the lungs, they go straight into the air and dissolve in it. On the other hand, tears formed in the proper glands, after washing and moistening the eyeball, gather in the appropriate sacks where they thicken slightly and flow down to the nostrils, and only here, retained for some time, they thicken properly and mixed with moisture oozing from the inner surface of the nostril membrane, they become a true excretion. So we surrender the matter which has lost

viability, through the large intestine, through the kidneys, the skin, the lungs and nostrils.

397. — *Excrement.* The excrement is formed in the large intestine because in the small intestine, where the chyle is perfected and soaks into the lymphatic vessels, the excrement is not yet to be seen; at least those remnants of undigested foods that sometimes appear in the final section of the small intestine have no features of true excrement. If food contains any non-viable matter, which can not be the object of organic elaboration, or viable matter which has lost all viability with respect to the *individual* that feeds on it or, due to a strong bond or chemical composition can not be dissolved in digestive juices; such matter, unchanged or only slightly transformed, mixed with digestive juices, has to pass onto the large intestine and be discharged together with excrement. The obvious examples are fruit stones and pips, hair, bones, etc., which are to be found unchanged or at least slightly altered in excrement. But such alien, accidental bodies, only mixed with the excrement, do not constitute its true essence, because this excretion has, in every animal, its specific form, colour, odour, and other properties little dependent on the nature of the food. So they can not be treated as have undigested remains of food and not absorbed by the sucking vessels, but, as a special animal combination, formed in appropriate organs, *individually* non-viable and, therefore, intended to be expelled beyond the limits of the body.

398. — Juices flowing into the intestinal tract and simply serving or helping to elaborate chyle can be partly

excrement material and, having passed to the large intestine, may become part of the excrement. Such a juice seems to be primarily bile which, although undoubtedly has remarkable significance in elaborating chyle, is basically an excremental juice, which proved by its abundance, although largely transformed, in the excrement. But, in my opinion, it is very certain that the entire inner surface of the large intestine is an organ elaborating from quite an abundant material, which is excrement proper, from less viable blood elements. The most evident proof is, *firstly,* absence of excrement anywhere but in the large intestine; *secondly,* its monotony regardless the kind of food; *thirdly,* its specific character in every kind and species of animals; we see that different species, even if fed quite the same plants or animals, produce excrement which is quite different and characteristic for them; *fourthly*, formation and sometimes very generous discharge of excrement in a time when very little or no food is used; *finally*, introducing, either by mouth or by enema, objects which are thick or cause irritability which do not work otherwise but by speeding up the organic elaboration or dissipation on the inner surface of the bowel, which is always followed by a profuse discharge of excrement. It is therefore important to consider the large intestine as an organ of secretion, elaborating excrement, partly including the material flowing down from the stomach and the small intestine. Partly including blood, which in this manner disposes of non-viable matter, just like via the kidneys, the lungs or the skin.

399. — We have not yet seen the exact analysis of human excrement which would teach us which elements the animal economy disposes of this way. The repulsive odour and abomination that we feel for it have been the most common obstacle, and this repulsion yet not overcome teaches us to what extent this matter is non-viable. Former works of Alchemists who, with the intention to transform metals, attempted to extract white oil displaying special properties from excrement, although have led to some inventions in Chemistry; nonetheless, regarding Physiology, they teach us nothing. According to *Mr. Vauquelin's* experiments, excrement is generally acidic and tends to acidic type of fermentation which, nonetheless, is very short, passing immediately into putrid fermentation and releasing a lot of ammonia which proves the abundance of nitrogen in this kind of excretion. Likewise, abundant emission of sulphur hydride from the rotting excrement and the conversion of metals into real sulphides, as well as the deposition of sulphur in the earth and rocks on which excrement rots, prove that this is the way the animal economy uses to dispose of sulphur. We do not even know what salts are contained in excrements; *Mr. Vauquelin's* experiments show that bird excrement contains a lot of calcium carbonate and calcium phosphate. If later experiments proved the abundance of these salts and human excrement, it would be proof that nature uses this path to dispose of earth salts originating from the elaboration of bone entering the blood.

400. — Excrement not always has the same colour and density. In children it usually is more fluid, in the elderly dry and hard. In new-born babies it is black, and in some diseases pale yellow or green. Its fetor has been unjustly attributed to rotting bile; the bile, even most decomposed, never has such an odour. This fetor seems to be rather appropriate to a particular animal combination affecting all relevant and characteristic properties.

401. — *Gases characteristic for bowels, or winds.* Apart from that, the entire digestive tract is always filled with gases, and is more or less flatulent and gases, when accumulated in greater abundance, are discharged, known by the name of winds. For this reason, these gases ought to be considered as true animal excretion. Experiments have shown that these gases are not always and not everywhere the same: the stomach, for example, and the upper part of the digestive tract are filled with carbonic acid mixed with, while the large intestine usually contain carbon dioxide and sulphur dioxide; therefore, much earlier perceptions have taught the Physiologists that this gas can inflame.

402. — Physiologists and physicians generally understand that these gases exude out of food due to a kind of fermentation, during imperfect digestion, or by the very activity of digestive juices; and to affirm this belief, the property of letting winds, long seen in certain foods, namely in legumes and almost all plant foods. But experience itself shows that such foods do not provoke winds in healthy

people with perfect digestion and, therefore, the precondition conducive to their abundant discharge is weakened digestive power as we see examples every day in individuals with poor digestion. In addition, daily experience teaches us that the emptier the digestive tract, the more winds it creates and releases; in such a case, these gases can not originate directly from food and, therefore, must be a kind of secretion on the inner surface of the bowels. For this reason, I consider the formation of carbonic acid as well as gas of hydrogenated carbon, hydrogenated sulphur and sometimes also hydrogenated phosphorus, as the real animal excrement, through which we discharge oxygen, carbon, sulphur and phosphorus. Equally unfortunate is an older claim that prolonged postponement and rotting of excrement in the large intestine results in rot and, consequently, a discharge of gases. Because in healthy people, such rot never occurs when the mentioned gases are always to be found in the bowels and always leave with the excrement, and thus are the usual effect of work of the bowels, meant to be discharged.

403. — *Urine.* Urine is one of the most important animal excretions, the discharge of which, can in no case, be delayed for long without endangering life. Therefore, nature has devoted a rather considerable body of organs to the elaboration and removal of this fluid from the body. The kidneys, located in the posterior area of the abdominal fascia, hidden and deeply buried in fat, receiving two large arteries directly from the *aorta,* are glands elaborating this fluid which flows

down from each kidney through a separate and fairly long duct into the bladder where it is collected and held until it has filled it entirely, and then it is discharged through the urinal channel (*urethra*).

404. — There are those who understand that not all urine is elaborated in the kidneys, but that part of it passes straight from the stomach and the intestinal tract to the bladder; and as evidence they quote the experiment in which it was seen that after tying the ducts leading from the kidneys into the bladder, the discharged urine was watery and quite abundant. Apart from the fact that none of the Anatomists has shown these ducts, none believe in their existence; the mentioned experiments must be erroneous or misunderstood because observation of nature and urgent attention paid to some cases of illness show that if elaboration of urine in the kidneys is suspended, none passes to the bladder. I myself witnessed two unfortunate cases of elaboration of urine held for several days caused by kidney stones where, throughout this time, despite the abundant drink and frequent baths not a drop of urine passed to the bladder. What would, in such a case, be those lateral paths, and would not the reciprocal nature open them on time?

405. — There is no other animal fluid which would have caught attention of Chemists, Physiologists and physicians as urine, and that is why there is not a fluid better known and perfectly analysed, so there is hardly anything to demand in this respect. Physiologists mark three of its types: 1) *drink urine* (*urine potus*), discharged shortly after the use

of a drink, which is watery barely yellow, and displays very poor characteristics of urine; 2) *chile urine*, or digestion urine (*urina chyla*) discharged shortly after the food is eaten, but before it is assimilated, and which is less abundant and not as watery as the former 3) finally, the *urine of blood* (*urina sanguinis*) discharged a few hours after using food, namely after a good sleep, so after nearly concluded elaboration of chyle into blood, which has all properties of urine in the highest degree. Because the first two types of urine are only the weaker or stronger solution of the latter; so only the latter should be considered in the description the properties of this animal fluid. It is a yellow in colour, with a touch of orange; has a distinctive scent, distinguishing it from all other animal fluids, and when fresh and healthy, its smell is not repulsive. The taste of urine is sharp, salty and slightly bitter: the temperature of freshly discharged liquid is between 29° to 30° *Reaumur.* Urine gravity differs depending on whether or not it is saturated, but never exceeds 1,080. Former Physiologists attributed alkaline properties to it which, however, only depict urine properly when it is decomposing, because fresh has all the acidic properties imparted to it by the acidic calcium phosphate which it normally contains.

406. — The most accurate analysis of the urine we owe to Messrs. *Fourcroy* and *Vauquelin*, who not only perfectly described all salts in dissolved urine, but also discovered in it a special animal combination on which all properties of this fluid depend and gave it the name of urin. This particular substance is found in the dense mass after evaporation

of the remaining urine, and can be separated by spiritus vini which dissolves it perfectly. It crystallizes into brown plaques and has this particular property that is strangely prone to the voluntary dissimilation, because the least degree of heat decomposes it with no delay; and there is no other organic combination which would be so durable persistent or so fast to decompose. However it decomposes, it always transforms into ammonium carbonate; this shows how rich this particular combination is in nitrogen, and brought to the degree of elaboration that, incapable of any further elaboration, strives towards forming simple chemical combinations. This, however, shows us that the animal economy disposes of a great deal of nitrogen via the urine, and other elements — such that have lost the most viability; therefore, kidneys are organs which, drawing out the most highly animated matter out of the blood, and the richest in nitrogen, dissipate essentially what is elaborated in the lungs. Hence, in equal circumstances, the function of kidneys should correspond to the function of the lungs, and the saturation and power of urine should correspond to the rate and degree of animal elaboration, or animalisation. The condition of urine shows us, in each case, the status of this elaboration and, in a way, somewhat the condition of lungs themselves. This is the fact of utmost importance in the art of medicine, though yet unknown to physicians assessing urine.

407. — But, in addition to *urin*, the urine also contains some protein and jelly, benzoic acid, urine acid, and, in

abundance, several types of salt, namely kitchen salt, ammonia salt and many phosphoric salts, such as: acidic calcium phosphate, magnesium phosphate, sodium phosphate, and ammonia phosphate. This is the way for the animal economy to dispose of phosphorus salts in the blood, in bones and other solid organs.

408. — A small amount of kitchen salt in the urine does not correspond to its abundance we use in food. Experience shows that salt is a compound favoured not only by humans, but other animals as well. They need and want it, seek it eagerly; man can not go without it. Analysing animal parts, however, both solid and liquid, we find very little kitchen salt in them, but we find salts based on sodium, namely sodium carbonate and sodium phosphate there. This brings about a conjecture that kitchen salt, by the power of digestion and action of assimilating juices, is decomposed into its elements; decomposed hydrochloric acid can be assimilated or passes to other kinds of combinations, while sodium serves as the base of other salts characteristic for the animal economy. It is far from true that animals may elaborate sodium from other elements they feed on; the more so that one can find it in the ashes only of these plants which grew on the seashore or in the vicinity of salty water.

409. — All the special features of the urine are dependent on the element which we have called *urin,* and this animal fluid is the stronger, thicker, and red the more *urin* it contains. Because through the urine and, therefore through the renal organ the animal economy gets disposes of great

part of the water, too, so the abundant and excessively consumed drink must give incentive to digest equally abundant and watery urine in the kidneys. In such a case urin, whose elaboration, with simultaneous animalisation of blood, is dissolved in a considerable amount of water, and the urine discharged in greater abundance, must necessarily be poorly, pale and watery. Similarly, the lack of liquid or dispersion and the significant loss of moisture by other excreta, such as: sweat, vomit, lax, not curbing the elaboration of urin which goes in its order, must result in less abundant urine discharge, but strongly saturated, dense red, and sharp.

410. — The second element specific to urine itself is the so called uric acid, composed of nitrogen, hydrogen, carbon and oxygen. Dissolved to saturation, it partly settles in fresh and warm urine after it has cooled, and in other circumstances otherwise equal, the more so the more urine is saturated. And since other urine salts are in the same category; therefore, after a very saturated urine has cooled down, a great part of them, especially more difficult to dissolve, settles on the bottom together with uric acid. The salts in question are calcium phosphate and magnesium phosphate. The abundance of this sediment is also fostered by the fact that, during intensified animal elaboration of blood, *urin* itself elaborates far more strongly, and therefore, its tendency to voluntary decomposition is greater; what makes the freshly discharged urine begin to decompose as early as in the bladder, giving rise to ammonium carbonate phosphate, acidic calcium phosphate and magnesium phosphate in the form

of simple calcium and magnesium-ammonium phosphate which settles at the bottom when uric acid is transformed into ammonium *urin*. Hence, in some cases, the presence of plentiful sediments that are commonly composed of animal mucilage and the salts mentioned above, and which we shall discuss in greater detail elsewhere.

411. — Because every animal secretion is considered to be a true organic elaboration, also urine does not separate from blood as it was once understood, but it is elaborated by the power of life and organic design of the kidneys, and is the true work and fruit of life. Although we say that animal economy disposes of nitrogen, water and phosphate salts through urine, but this is not to be understood otherwise but as kidney elaboration of urin, uric acid, and animal combinations in a due course and order of continuous series of organic transformations. These combinations are highly animalised and, thus, can not be subjected to further elaborations; which is why they must be the material of excreta which they, indeed, are. And since *urin* is abundant among these excretional combinations, thanks to its very elaboration the animal economy, namely blood, disposes of a huge quantity of this element. And thus nature, interweaving the entire animal life from the various closely related organic elaborations, graduated and properly following each other; each entrusted to a specific organ; and let me put it this way, bound into unbroken unity, they help each other and can not exist in separation because some prepare and continually provide for others the only material to elaborate and

maintain an unbroken activity. When one starts a course of elaborations and receives viable matter from outside, others, having received the matter already transformed in a way specific to themselves, expel it beyond the limits of the body. If, therefore, in this entire decent chain, even if one active link was no longer in operation, the whole course of elaborations would become confused, disorganised, and finally they would have to cease.

412. — Thus, from the organic or physiological perspective, the kidneys are organs which elaborate an organic combination most strongly *animalised*, and therefore one that can not be further elaborated in any way in the body from which it is derived. And in the simple chemical terms, they are organs via which the body disposes of the superfluous nitrogen, water, and many salts, namely phosphorus salts, and thus organs which prevent unnecessary excess of these elements from collecting.

413. — *Skin vapour or perspiration.* The entire very large surface of the skin, being in contact with air, is both a shell of the whole body and an organ which receives and takes viable elements from the air and returns other similar or different elements. It is only a conjecture that the skin takes something from the air, so far no not proven in a simple and obvious experiment. Because the fact that bodies rubbed on the surface of the skin penetrate into it; the fact that the volume of water used to bathe is reduced and is assimilated by suction vessels is quite certain, but so far no experiment has shown that the air itself is ingested by the skin or water

dissolved in it. It is, therefore, unknown whether the body assimilates any viable matter through the skin and what kind; the fact that it surrenders some elements is quite certain. For this reason, the skin must be considered to be an excretional organ that is, elaborating animal combinations which are transferred into the air. And since this excretion is not visible, it can only be a gas or some vapour, such that instantly dissolves in the atmosphere. Despite a great number of experiments and work undertaken to explain perspiration we have not yet learned whether a kind of gas appears on the surface of the skin. If so, what gas? Although there are people who would like to consider organic activity of the skin to be identical to the lungs, understanding that carbonic acid gas forms here, too, but later experiments proved this hypothesis to be erroneous. Having wrapped the whole body, or part of the skin, in a substance which would stop both gasses and water vapour exuding from the surface of the skin, we find nothing but water vapour in a small amount.

414. — It is dirt left on the underwear which teaches us that water vapour is not pure water; we learn about it from a specific, characteristic odour which not only varies in different genres and species but in *individuals* of the same species; which in some animals is unbearable; which the dogs use to smell and recognize the species of an animal from far away and identify their master, catching wind from considerable distances and following his tracks. This skin odour is annoying in the sick and the old and pleasant in the healthy, young and fresh. Hospitals and prisons infected by

this vapour have a particularly unpleasant odour, called the hospital aroma by experienced physicians. The water vapour exuded by the skin is thus not pure water, but a specific watery combination elaborated by this organ, easily dissolved in the air, whose nature and elements are little known to date. Moreover, this animal combination, when formed in illness and dissolved in the air, is often a real plague, bravely transformed and destroyed by peroxyacid, a compound which readily decomposes organic combinations.

415. — *Sanctorius's* experiments, performed in the early seventeenth century, are famous among physicians and physiologists. For thirty years he weighed the amounts of food and drink he had been eating and, also weighing, compared it to his own stool and urine, trying to find out how much, at the time, he exuded through the skin. These experiments, later repeated by *Dodart*, *Robinson*, *Rye*, and *Linnings* all had this inaccuracy in calculations in that they did not distinguish what we were losing through the skin from the loss we are sustain through the lungs, and that in the calculation of matter taken in as food and drink neither included those elements which merge with blood in the lungs nor which lymphatic vessels could tale in from the air.[47] In their later experiments, *Lavoisier* and *Seguin* tried to distinguish and separately assess pulmonary vapours from skin perspiration alone, but their work was far from perfect as would

47 It is not proven (113) whether we take whatever from the air through the skin, but it also has not been proven that we do not.

be desired. From all these experiments we only learn that, *firstly*, we lose as much in the twenty-four hours in various excretions as we consume in food and drink, in short, that weight of the body neither visibly increases nor decreases. *Secondly,* that, foods, especially dry ones, do not increase the skin excretion so much as drink does. *Thirdly,* that in view of the large area of the pulmonary vapours, they are far more abundant than those exuded through the skin.

According to *Lavoisier* and *Seguin*, the highest amount of skin vapours is 32[48] grans[iii] per minute, while the smallest is 11 grans. The result of earlier static experiments was that a man taking six pounds of food and drink, after twenty-four hours, when he returns to his original weight, usually loses three pounds in urine and five ounces in excrement, so that invisible vapours amount to two pounds and seven ounces. But who would not see that this amount must necessarily be offset by the loss suffered by the lungs?

416. — Keeping up with the latest breathing experiments performed by *Mr. Davy* it follows that: a not very tall person with small lung capacity digests 32.6 square inches of oxygen and produces 26.6 inches of carbonic acid. And

48 This amount seems too big, because in this way the skin vapour discharge would equal to eight pounds in 24 hours, while *Sanctorius* himself, counting the skin and pulmonary discharge never estimated it in excess of five pounds.

iii Gran — 0.0648 grams.

since a cubic inch of carbonic acid weighs 0.68985 gran; so the amount of this acid formed per minute is 18.35001 gran, or 1101.00060 grans per hour. And, according to *Lavoisier's* calculations, carbonic acid contains 0.28 parts of carbon and 0.72 of oxygen; so what we lose through the lungs amounts to 308.28016 gran of carbon per hour, or five drams[iv] and 8.28016 grans: it gives us, in twenty four hours, one pound, three ounces and three drams and eighteen gran apothecaries' weight. So if, we were to subtract only the amount of carbon lost by the lungs from the coetaneous discharge, this vaporous discharge would be not more than merely a pound, three ounces, four drams and forty two gran. But considering that in the lungs we find not pure carbon, but rather carbon dioxide, the amount of coetaneous discharge will decrease even further.

417. — However, it seems that the amount of hydrogen separating from blood in the lungs is negligible; according to the experiments mentioned above, we use 31.6 cubic inches of oxygen per minute, which makes 15.8 grans, and we produce 18.35001 gran of carbonic acid. And, according to the *Lavoisier's* calculations, one hundred parts of carbonic acid contain 0.72 of oxygen,[49] so this element enters carbonic

49 It is impossible and unlikely to tell in what state of oxidation the carbon is released from blood. Because, according to *Mr. Guyton's* experiments, plant carbon is already an oxide, so no more than 17.88 pure carbon and 82.12 oxygen is contained in the carbonic acid. If we were to

iv Dram — 3.888 grams.

acid at the rate of 13.212072 gran per minute; so, even if it did not even enter the blood at all, which is quite probable, its amount used to create water would be 2.587928 gran per minute: what should convince us that very little water is produced by breathing. Experience convinces us that the air exhaled from the lungs is heavily burdened with water vapour[50] because in the cold weather this vapour is visible; so, in the lungs a large part of the water passes from blood into the air which, again, greatly increases the amount of pulmonary vapours and reduces the skin vapours. However, the amount of nitrogen merging in this organ with the blood ought to be subtracted from the losses sustained by the lungs, which *Mr. Davy* estimates at 5.2 cubic inches per minute, which gives 2.31088 grans and, therefore, in four hours: six ounces, seven drams and twenty–seven gran.

418. — Anyhow, wondering how much water vapour passes through the lungs, it must be admitted the need that the whole mass of the skin excretion is far less than had been understood. And this kind of excretion, like all other, increases or decreases in accordance with changing circumstances. Those circumstances, fostering its proliferation, are as follows: 1) increased rate of the course of life 2) abundance

put aside so much oxygen for the formation of carbonic acid, there would be none left to merge with hydrogen. But even supposing that carbon is already present in the blood in the state of an oxide just like carbon itself, it always seems that water is not formed, or very little.

50 It can not be pure water vapour, but a type of animal combination in the state of vapour; it is proven be its odour, in some cases very strong.

of fluid 3) raised ambient temperature 4) finally, increased dissolving power of air. And because this excretion, according to what we know so far, is watery; so proliferation of other similar excretions can reduce it, and reduction can cause its proliferation. This is why physicians perceived a long time ago that the skin discharge intensifies following urinary discharge or lax and when it intensifies, those two decrease or cease. If the dissolving power of air is strong, the skin is dry even during heavy perspiration; in the opposite case it all covers with moisture of which we have given the name of sweat.[51]

419. — Sweat presents itself in two different circumstances: firstly, when the elaboration of the skin vapour is more abundant compared to the dissolving power of the air around us, secondly, when the dissolving power of the latter is significantly reduced.[52] The first case occurs during

51 This dissolving power of the air, as I have shown elsewhere, grows alongside with the indications of the barometer and clarification of the sky, depending on the perfect dissolution of water suspended in the atmosphere. In such air we feel inner lightness, sobriety and propensity to move, very weak disposition to sweat and reduced excretions by stool and urine.

52 1) There were physiologists who assumed the presence of separate vessels in the skin, producing invisible evaporation and, separate producing sweat. But, *firstly*: the latter is not an ordinary excretion, and therefore can not own separate organs. 2) As it has been proved that the skin evaporation is mostly watery, so in order for it to become visible, in other words, to transform into sweat, it is enough to either reduce the

the rapid movement of the body, during work, after abundant warm drink and when the body is wrapped in material protecting it from the access of air, not easily permeable to caloric. The second case occurs when the air is warm and humid, especially when its water dissolving power is so reduced that it begins to release water in a significant amounts, as it is in summer before the storm. The air has strongest dissolving power in the cool air, and when the weather is excellent, at that time when the barometer reaches its highest; at that time the skin vapour is the most profuse; on the contrary, it is the poorest in humid and cool air. External heat increases it, especially in dry air. But one should never immediately judge the dryness or moisture of the skin by profusion of vapour; in dry and cool air the skin is so dry that it may even crack though the vapour is profuse, but invisible to the great dissolving power of the air; on the contrary, in the warm and humid air the whole skin is covered by moisture, although the amount of vapour is actually smaller. In any case, one should note that the skin vapour is an organic elaboration, and its quantity and properties depend on the general condition of the organism and of particular organ where it is elaborated. And its presence or absence not only depends on the state of the whole machinery and the condition of the skin but also the status of the air. Therefore, sweat

dissolving power in the air or to increase the volume of the evaporation so that it exceeds this power. After all, by shielding the skin and stopping the access of air through plasters or oilcloth, etc., we change the invisible evaporation into sweat.

itself is neither a sign of enlarged or reduced perspiration, as it may appear in the first case and in the other.

420. — But if the dissolving power in the air is not intensified, if the bloodstream is accelerated and the animal heat is excessive and the skin is dry, it must be said in fairness that the skin vapour will be significantly reduced or completely halted. The example of the above is to be found in fevers; when they cease, skin vapour returns signifying their end. Similarly, the undoubted feature of increased skin vapour is the sweat which occurs by itself, without the rise in external temperature and a decrease of the dissolution power of the air; this phenomenon is often observed, both in health and in illness.

421. — Sweat is a salty fluid showing, at first, indisputable signs of free acid which, due to decomposition will soon vanish and give way to alkaline properties. Sweat, therefore, seems to be similar to the urine, to which some physiologists have compared it. There are those who would like to see oiliness in the sweat, bile and even blood; others saw salt crystals left on the surface of the skin or in the lining of the underwear. *Fourcroy* and *Vauquelin* discovered that horse's sweat created a rather abundant deposits calcium phosphate. Dirt on the surface of soiled bodies and long-worn undergarments seems to be a kind of extract remaining after the watery part of sweat has evaporated, but as yet is not quite known. All this convinces us that careful analysis of sweat is worth engaging the time and attention of the Chemists in the future. Pathologists have often unreasonably been

ascribing a great deal of suffering to halting sweat or skin vapour, and sometimes in cases where they are not only halted but excessive. We shall have the opportunity to reflect on it elsewhere.

422. — *Tears and moisture covering the nostrils.* Tears are formed in special glands located at the upper lateral region of each eye. They flow through several separate ducts, moisturise the eye, spreading over the entire anterior part of the eyeball under the eyelids. After washing and moisturising the eye, tears sink into two apertures, located in the proximity of the inner corner of the eye, called lacrimal points. These apertures mark the beginning of small canals draining tears into sacks located on both sides of the external part of the nose; at the end of those sacks there are ducts through which tears flow into the nose. They are a liquid elaborated from blood that first moisturises the eye, then the nose and, finally, becomes a true excretion. All along the way, the suction vessels slowly collect the watery part, thickening the tears a little; the thickening takes place essentially in the nostrils, because much of the water dissolves in the air and the remaining tears attract oxygen from the air. Experiments performed by *Mssrs. Fourcroy* and *Vauquelin* have shown that tears thicken merging with oxygen, and lose the property of dissolving in water. Those Chemists themselves have found in them some sodium carbonate, kitchen salt, sodium phosphate, and calcium phosphate; In addition, they found animal mucilage which very easily attracts and thickens oxygen from the air.

423. — The entire surface of the membrane lining the inside of the nose is moisturised by a kind of sticky liquid which covers it entirely. The liquid, elaborated by follicles spread all over the mentioned membrane, should also be considered as an exertion. Elaboration and discharge of this liquid increases during colds, when it is abundantly collected. According to the experiments performed by *Mr. Vauquelin*, this fluid is similar to tears, possessing the same elements, but animal mucilage in it is far more profuse and thicker. This mucilage does not dissolve in water and equally greedily attracts oxygen, just like tears do. In the cold, at first it is discharged in great abundance and, towards the end, thickens and changes all its properties.

THE END OF VOLUME TWO.

SPISANIE RZECZY W TOMIE DRUGIM ZAWARTYCH,

Z WYKŁADEM TREŚCI ROZDZIAŁÓW.

Stronica.

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JĘDRZEJ ŚNIADECKI.

TEORYA

JESTESTW ORGANICZNYCH,

PRZEZ

JĘDRZEJA SNIADECKIEGO

RADZCĘ STANU, AKADEMIKA I PROFESSORA KLINIKI W CESARSKIÉJ MEDYKO-CHIRURGICZNÉJ AKADEMII WILENSKIÉJ, KAWALERA ORDERÓW ŚWIĘTÉJ ANNY DRUGIÉJ KLASSY Z CESARSKĄ KORONĄ I ŚWIĘTEGO WŁODZIMIÉRZA TRZECIEGO STOPNIA, CZŁONKA WIELU TOWARZYSTW UCZONYCH.

Tom III.

WILNO,

W DRUKARNI DYECEZALNÉJ U XX. MISSIONARZY
NA GÓRZE ZBAWICIELA.

NAKŁADEM RUBENA RAFAŁOWICZA KSIĘGARZA WILENSKIEGO.

1838.

A NOTE ON JĘDRZEJ ŚNIADECKI'S LIFE AND PUBLICATIONS (*)

The days devoted to the most beautiful profession of all, to sciences and the suffering of humanity, to the public, have come to an end. On 29th April 1838 Jędrzej Śniadecki passed away among universal grief and general praise. Holding various scientific and academic titles: Doctor of Philosophy and Medicine, Professor of Chemistry at the former University of Vilnius, Academician and Full Professor of Therapeutic Clinic in the Imperial Vilnius Academy, President of the Medical Society, state councilor, recipient of the Order Of St. Anna, Second Class with Imperial Crown, and the Order of Saint Vladimir, Third Grade, bestowed those tiles and orders more lustre than they did to him, and deserved more. Born on 30th November 1768 in his father's village near the town

(*) This biography is quoted from the first volume, pp. 114 to 127 of the new second edition of *Wizerunki i Roztrząsanie Naukowe* [*Scientific Images and Deliberations*]. Wilno, 1838, t. 1, with the publisher's kind permission.

of Żnin, in the county of Kcynia, in the former Gniezno Voivodeship, now the Grand Duchy of Poznań,[v] he began his education in a small school in Trzemeszno. After the death of his parents, under the auspices of his brother, he was thoroughly educated in various subjects in six classes of the local school. Excelling in all of them, and surpassing all other students in diligence and sharpness of mind, in 1787 he was granted the golden *Diligentiae*[vi] medal by King Stanislaus Augustus himself, following a public presentation of his abilities. These successes at an early age, confirmed by the public opinion, amazed everyone, and were a premonition of a rising genius whose profession was not yet guessed. At

v The Grand Duchy of Posen (German: Großherzogtum Posen; Polish: Wielkie Księstwo Poznańskie) was part of the Kingdom of Prussia, created from territories annexed by Prussia after the Partitions of Poland, and formally established following the Napoleonic Wars in 1815. Per agreements derived at the Congress of Vienna it was to have some autonomy. However, in reality it was subordinated to Prussia and the proclaimed rights for Polish subjects were not fully implemented. The name was unofficially used afterward for denoting the territory, especially by Poles, and today is used by modern historians to refer to different political entities until 1918. Its capital was Posen (Polish: Poznań). The Grand Duchy was formally replaced by the Province of Posen in the Prussian constitution of December 5, 1848.

vi Medal *Diligentiae* — a medal established in 1767 by King Stanisław August, presented to alumni of the Cadet Corps in Warsaw (Academy of the Nobility Corps of His Majesty and the Republic) as an honorable distinction for diligence in science. The medals were awarded in 2 categories: gold and silver.

once, he began to apply his mind to mathematical sciences in the ancient Academy of Cracow, where his older brother had already gloriously devoted his part of his life to the queen of sciences. His goal was to become an engineer and enter the French service, but then, after changing his original intention he devoted himself entirely to medicine. After extending his course at the Academy by two years, following the advice of his brother and caretaker — the famous Jan Śniadecki — he travelled to Italy, where the medical sciences had flourished. For two years in Pavia, diligently listening to lectures delivered by eminent physicists and medics of his age: Johann Peter Frank, Spallanzani and Volta, he developed bonds of friendship with them, earned the most honourable testimony for his work and was ceremoniously granted a Doctor's degree (16th May 1792). From Italy he went to London and Edinburgh. There, he practiced the medical arts with unparalleled zeal under the guidance of the foremost surgeons; like earlier in Italy, now in England, he perfected the language to such a degree that he was able to enrich many of the periodicals of this epoch with wit and narrative so brilliantly as if he had been a native Englishman. Only strong attachment to his own land and his brother detracted him from the intention to travel to East India where, with the help of famous doctors Gregory and Monro and other friendly Scots, he was made an offer awakening to hope for prompt achievement of fame and great fortune. After beneficially spending some time at the University of Edinburgh, he went to Vienna in 1795 and, at the Viennese Medical Academy, which surpasses by far all other German schools of medicine, boasting a collection of famous teachers and establishments, he completed his knowledge acquired so far with a year and a half of diligent studies.

So remarkably disposed with a wealth of teaching, the master came back to the country which he had left seven years earlier as a young man, full of zeal for learning and full of hope. The Vilnius Principal School, now reborn and having cast away outdated formulas and teachings, but again plagued by domestic troubles, tried to elevate itself, inviting academics who were aware of the new system of public instruction in foreign countries, to regain fame. The first in this respected circle was Jędrzej Śniadecki. Called to Vilnius as a Professor of Chemistry, he initiated the course of this science in 1797. He, and venerable Mr. Jundziłł, became a core of what was later to emerge as the Vilnius University, whose development and popularity was largely their contribution. The unmatched grace of eloquence, coupled with the profound knowledge of this new and interesting science, immediately captured universal attention of the public, not used to employ in such matters. But then, this Chair, under the guidance of the such a distinguished master, gaining popularity with every new day, aroused such enthusiasm and attracted so many listeners, not only students of the University but also from among all classes of the society at that time, that nothing similar to this was to be seen before in Poland. Such talent and such fame are hard to conceal, and the news quickly spread by word of mouth. How many people suffering from serious illnesses did he then bring the desired help, how many who had lost all hope did he tear from the arms of death? The feeling of gratitude is universal in the whole country, those families will remember what he had done for generations.

Apart from such important and profound tasks, devotion to sciences and to the suffering humanity, between 1800 and 1810 pondering and labour in all areas of physical and medical skills were a constant element of Jędrzej Śniadecki's mighty genius. It perpetually inclined him the exercise of mind, devoting all the time that the world spared him to reading and continual practice in his chosen subject; he was far from imagining that the need for incessant improvement and progress in the sciences might cease, once he had achieved the status of an academic teacher.

Indeed, enthusiasm for his vocation grew alongside with his fame. This happy mind easily absorbed the whole spectrum of sciences he had devoted himself to, and inventions with which Europe enriched them. At his initiative, and as a fruit of work shared with a reputable scientist, Mr. Groddeck, and our distinguished naturalist, Mr. Jundziłł, the first natural science periodical was published in Vilnius in 1805: *Dziennik Wileński*.[vii] Material appearing in this periodical, presented in more or less popular

vii *Dziennik Wileński*. Wilno: [s. n.], 1805–1806; 1815–1825. [*Vilnius Daily*].

language, began to make our province familiar with the most important skills employing Europe at that time. Jędrzej Śniadecki captured public attention with his lecture on most interesting Gall's system,[viii] which he presented in the periodical, and among many other excellent treatises he wrote: *O fizycznem wychowaniu dzieci*,[ix] read with interest even by those who ordinarily would not employ themselves with reading, and with gratitude of mothers, which is evidence of his great talent for observation and experience in the most important subject — all for the good of mankind. Apart from such literary works, which for him was just entertainment, enduring considerably heavier public teacher's hardship, he published *Początki Chemii*[x] in three volumes, shining with so many lustrous examples that he became the father of chemical nomenclature in the Polish language. The striking lecture on the new theory of dissolution, laying the first foundations and principles of chemistry as a science and, in general, exemplary style, clarity and accuracy

viii Śniadecki, Jędrzej. Krótki wykład systematu Galla z przyłączeniem niektórych uwag nad iego nauką. *Dziennik Wileński*. 1805, t. 1, nr 1, p. 16–43. [*A short presentation of Gall's system, including some remarks on his teachings*].

ix Śniadecki, Jędrzej. Uwagi o fizycznem wychowaniu dzieci. *Dziennik Wileński*. 1805, t. 2, nr 5, p. 1–32; nr 6, p. 113–145; t. 3, nr 7, p. 225–247. [*On Physical Education of Children*].

x Śniadecki, Jędrzej. *Początki Chemii* (…). Wilno: Druk. Akademicka, 1800, t. 1 [*Origins of Chemistry*].

of ideas elevated this book immensely in the opinion of all readers, and the text itself transpired to be truly beneficial for the students. *Dziennik Wileński*, restored in 1815, was also enriched by several important treatises on chemistry and medicine written by this splendid author. Later, in *Pamiętnik Lekarski Wileński*[xi], he presented many subjects focusing not only on medicine, rendered in his characteristic, beautiful style. Albeit, preceding the epoch when medical science attracted Jędrzej Śniadecki's pen, this great practitioner had long enjoyed literary fame. In 1804, he published a work[xii] in Warsaw, which set him at once in the order of the most distinguished physiologists, and throughout Europe his name was made famous. *Teorya jestestw organicznych*[xiii] will be a splendid monument of ingenious ideas of this famous man, whose loss is so painful today. The work was immediately translated into German,[xiv] and then joined

xi *Pamiętników Towarzystwa Lekarskiego Wilenskiego*. Wilno: nakładem i drukiem Józefa Zawadzkiego, 1818–1821. [*Memoirs of the Vilnius Medical Society*].

xii Śniadecki, Jędrzej. *Teorya jestestw organicznych*. Warszawa: Druk. Nr 646, 1804, t. 1 [*Theory of Organic Beings*].

xiii Śniadecki, Jędrzej. *Teorya jestestw organicznych*. Warszawa: Druk. Nr 646, 1804, t. 1; Wilno: Druk. J. Zawadskiego, 1811, t. 2. [*Theory of Organic Beings*].

xiv *Andreas Sniadezki's Theorie der organischen Wesen* / aus dem polnischen überssetz von Joseph Moritz. Königsberg bei Unzer: [s. n.], 1810, t. 1 ; *Andreas Sniadezki's Theorie der organischen Wesen* / aus dem polnischen überssetz von Andreas Neubig. Nürnberg: Zeh, 1821.

the ranks of French literature in a very good translation by Messrs. Ballard and Dessaix,[xv] who were familiar not only with the language from which they translated, but also with author himself; they had an opportunity to appreciate the author's wit and qualities of mind. The introduction to their French translation of the *Teorya jestestw organicznych* will always be a testament to deep sentiment the foreigners endorsed, and retained for Jędrzej Śniadecki.

Over the whole course of his honourable he practiced, among days and years spent constantly either on enlightening the juvenile minds and preaching profound and useful truths, or saving not only individuals suffering from illnesses, but entire families of in despair and fear; among a variety of glorious and blissful deeds, he found time to commit himself to other types of literature. Many remember well his humorous articles in the once-famous *Wiadomości Brukowe*,[xvi] marked by a touch most delicate satire, addressed at no one in particular, but aimed at the repair the entire community. There may be but few who would not unanimously admit that these brochures, and the literary society who published it, exerted salutary moral influence on our entire province. Only those unaware of matters and social status at that time, or judging their views according to present standards,

xv *Théorie des êtres organisés, renfermant les généralites de la vie organique* / par André Sniadecki, traduit du polonais par J. J. Ballard et J. M. Dessaix. Paris: Gabon 1825.

xvi *Wiadomości Brukowe*. Wilno: [s. n.], 1816–1822. [*Pavement News*].

regardless of the level of civilization twenty years ago, can deny this truth. And even if a considerable part of the articles published in it aroused merely contemporary and transient interest, appropriate to the circumstances, not leaving behind true scientific value, Jędrzej Śniadecki's wit found an opportunity and venue to present his power and grace in full flourish. His writings, more important than the above diary, and the times to which he devoted his attention, will forever occupy a high position in the ranks of lighter literature, and will bring their author fame and new laurels. The list would be imposingly long if we wanted to enumerate all the other minor articles and discourses on physical and medical subjects placed in various national journals where this deeply thinking physician-philosopher presented more than once the most recent original ideas and thorough reasoning in a small volume of text. There is no doubt that if not foreign, and then local doctors and physiologists can properly assess his splendid qualities, and will eagerly pay homage to Jędrzej Śniadecki's merits, both in his practice of medical profession, and in his writings.

Exhausted by long years of work, he was released from the public service on June 4, 1822 as a retired university professor. But he could barely rest for two years, and the public voice and the urge of the educational authorities called him to occupy the vacated chair of the clinic, which he henceforth did not leave, working until the end of his days. Here he entered a new profession of tutoring young people who devoted themselves to medical science by way of practice, which he himself was proficient in, and without which all medicine would be only a transitory and harmful wrap of intricate and vague ideas. Under the tutelage of such a teacher, clinical lectures and classes became a source of inspiration for a large number of young physicians who have brought true benefits and upheld honour of the country, winning the Vilnius Academy of Medicine and Surgery respect and fame.

Te death of this man of virtue and unforgettable fame, this great counsellor of the suffering humanity, came after a long illness on April 29 / May 11[xvii] at about quarter to two in the afternoon. Before the torch casting light on the reborn civilization in Lithuania at the end of the past century finally dimmed, it had been shining brightly onto the present generation. Jędrzej Śniadecki's domestic virtues, his tender affection for his children and grandchildren, gentle care for his peasants, generosity and courtesy displayed in the society, accompanied by extraordinary with a sense of humour, with no detriment to his advanced age, endorsed him as much as public merit. In addition to such qualities, characteristic of noble and amicable men, his character was exceptional; he was bright and strong minded, and displayed rare, unquestioned integrity: the three principal characteristics of that extraordinary man whose life may serve as a model; the memory of him will be preserved for the posterity. General regret and worship expressed at the coffin of this

xvii April 29/May 11 — notation of dates according to Julian Calendar, used in Imperial Russia, and Gregorian Calendar.

man on May 3, when it was carried from his home to the church and, the next day during the service and relocation to his hereditary village, articulated by tens of thousands of residents of the city and visitors from the province, amply testifies for the verity of all we have said about the lustrous life he had lived. Jędrzej Śniadecki has kept the promise given in the quotation chosen from Kochanowski at the opening of the *Teorya jestestw organicznych*. "He served a good cause and, inasmuch he could, work towards the common good."

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CHAPTER XXIX

SOME CONCLUSIONS FROM
THE PREVIOUS LECTURE.

424. — The path and circulation of viable matter through organic beings, defining their lives, discussed in general terms in the first part of the present writings, has now transpired in detail, and in the most perfect and most exalted manner. Surrounded by raw or organized viable matter and surrounding ourselves with it, we acquire it incessantly from the air, from water, and other organic beings. Thus acquired, the matter passes through a number of organs which hand it over to one another and where, as a result of activity of various animal fluids, it is dissolved and processed, gradually embracing and receiving the animal nature of the being into which it is introduced. This constant uptake of viable matter and its transfer from one organ to another employs them all it and maintains their activity which constitutes their life. In the living body itself, everything except excretions is viable matter, but not in equal measure for all organs; everything, therefore, is elaborated and becomes subject to further elaboration, and the movement of life always and ever present, perpetually advancing; constant assimilation proceeds

everywhere, the exchange of matter and organic elaboration and dissipation continues everywhere. The circulation of blood and the fact that it reaches every organ and every living point is a way of supplying matter ready for elaboration everywhere. Lymphatic vessels are channels through which the dissipated organic parts return to the blood, therefore, blood is the storage of matter which can be subject to all kinds of elaboration and dissipation, yet simultaneously such that has already passed through some or all elaboration and dissipation, and for which the limit of further assimilation is more or less defined. From the first instant of introduction of viable matter into the living organism, organic combinations are continually formed, being the material for next ones, and next ones again and so, endlessly, towards he final ones which already constitute a non-viable combination for all those preceding, and are expelled beyond the limits of the body. Thus, every living part, every organ, every point of the organism helps universal life and is part of its sustenance, being reciprocally sustained by it. Thus, the entire body and all its parts are an abundant store of viable matter and, to a certain extent, suffice one another in sustaining life; those at the end of such organic elaboration can not cease to exist voluntarily as long as universal life continues. But others, which are at the beginning of that chain, need continual uptake of external matter, otherwise, although temporary failure to supply such matter will not immediately end universal life, because blood can flow and nurture other organs for a long time and sustain their activity until it is completely exhausted, but preventing the supply or stopping its circulation must immediately result in death; because once the supply new matter to the organs via the circulation path ceases, the activity of them all together must cease; and with it, the movement of life at all points together will be halted.

425. — I have explained and tried to show in the first part of this lecture that the whole of organized entities can be regarded as organic unity embracing all degrees of elaboration; the single links of this huge chain serve universal life just like single limbs in an *individual*. A man, who is placed so high in this chain, and feeding on so many different beings, is like a better elaborated organ for whom all preceding beings prepare viable matter to facilitate its assimilation. And so, life is the same in every *individual*, in every organ, every living point, in the whole enormity of the animated world, everywhere it consists in the movement of viable matter, everywhere it is its constant transformation. Types and species belong to one whole; just as separate parts and members of any *individual*: and nature, just like enormity of the world and in its every point is the same everywhere: simple, amazing and great.

426. — In such a manner of matter circulation through the human body, chemical or organic combinations are formed in some organs, which later leave the limits of the body, and thus, utilising blood, the entire animal organism disposes of viable elements which it was constituted of. And so, we dispose of carbon and water through the lungs; likewise, nitrogen and phosphoric salts through the urine;

probably similarly we dispose of salts, as well as sulphur, carbon, and phosphorus; and we dispose of water vapour almost only through the skin, as far as we know.

427. — By applying these different excretions to ourselves, we can see that there is not even one through which we would dispose especially of oxygen, unless we considered all watery excretions as the way of disposing of it. But considering, on the other hand, that the entire course of plant elaboration is a continuous decombustion (108) and that animal beings elaborate from plant beings, it ought to be necessarily admitted that either the process of decombustion does not pass the limits of plant life throughout the organic kingdom; or that animal beings must lose oxygen via some organs. And since the latter conjecture has not been proved so far, it is appropriate, from the chemical standpoint, to consider animal life as a process and a way of disposing of carbon and acquiring nitrogen. On the other hand, if animals acquire most of the oxygen in drink, i.e., in water, then by again creating free excretions they can again return as much as they have acquired; and thus maintain the balance of the elements of their own matter. But since they spoil some of the oxygen in the lungs in order for carbonic acid to form; so in that case it is necessary to solve the important question in Physics; where does the oxygen in the atmosphere come from? Plants, however, create it on the one hand, but spoil the same amount on the other (109).

428. — Those who introduce oxygen into blood in the lungs should show, *firstly*: the paths through which it leaves

the body; *secondly*: they should prove that this element is indeed essential for *animalization*; which, in the present state of our knowledge, is unlikely. The fact that animals can not live without access to oxygen must be explained by the necessity of forming carbonic acid and water in the lungs. After all, plants also need access to this gas in the shade (109), but they do not inhale it; besides, animals can not live long in oxygen only; breathing oxygen, they form less carbonic acid and, therefore, they do not need oxygen to live and breathe but, indeed, the atmospheric air. Moreover, when conjecturing that oxygen enters the blood, it is necessary to assume its thickening to the density of the blood itself; and such strong density of oxygen and nitrogen could lead to the chemical bonding of these two elements. Even some experiments with animal beings seem to oppose this conjecture because oxygen thickens all animal fluids and leads to clotting when the blood, turning into arterial, becomes more fluid. All live animal organs, when in contact with oxygen, are disorganized and spoil, as is evident in immense pain and inflammation of organs which have been skinned and immersed in oxygen; just as we are convinced it is so when bare animal organs are exposed to acids of metal oxides and acidified salts. Until obvious experiments convince me, I shall remain doubtful; I can not believe in combining oxygen with blood in the lungs; indeed, I consider this element as obstructive to animal elaboration, and always harmful in unnecessary quantities.

CHAPTER XXX

THE LIFE OF NERVES AND REVELATIONS DEPENDENT ON IT.

429. — We have said above (189–233) that nerves are an organ of sensation. That it is so, the simplest experiments and perceptions will convince us. Organs such as hair, nails, horns, hooves and parts of bones not reached by the nerves do not feel; even in the most sensitive organs this power is lost when a nerve which enters a given organ is tied, damaged or cut through. Similarly, organic beings with no nerves do not give any signs of feeling, or at least do not show the changes through which we usually give the signs of feeling. To feel is to recognize an object that directly or indirectly touch us and acts upon us, or at least to recognize that objects act upon us.[53] So. Thanks to feeling we judge the presence or existence of objects and the way they act upon us. But everybody acts with the power of its own upon all the surrounding creatures, and therefore, both on those equipped with nerves, as well as on those deprived of nerves;

53 This definition may not express and reflect feelings perfectly well, but it is also true that the term does not need a definition.

therefore sensation and feeling occurs only in the nerves; it must be a phenomenon attached to organism and life, which we will now analyse and study in more detail.[54]

430. — A damaged or strained nerve, dissipated, i.e., disorganized or dead, carries no sensation; so feeling or sensation is a phenomenon of nervous organization and life. And because life and all its phenomena constitute an organic process based on self-organization and dissipation of viable matter, embraced by some kind of movement; therefore feeling and sensation can not be anything else but a certain kind of movement of nervous mater based on its renewal, because it only takes place within it. In short, feeling is a phenomenon of life and organization in the nerves. Life in general is a constant organization and renewal of matter, therefore, feeling is a renewal, i.e., elaboration and dissipation of nervous matter.

431. — In animals, as we have seen above, the neural tissue constitutes specific and extensive systems whose shared

54 *Haller* first attempted to show in his experiments that the power of sensation serves only the nerves, and that in those body parts where nerves do not enter, it is not present. The experiments and reasoning of his opponents who had attempted to overturn this thesis prove only so much that the great Physiologist denied the presence of nerves in some organs. For wanting to establish that without nerves all the organic parts of the animal body are able to feel is to establish that the whole organic kingdom is capable of feeling, and thus that feeling and life one signify the same thing, which is ridiculous and only misrepresents the meaning of words.

centre and the most prominent seat is to be found in the head. The pulp, whenever it goes, is capable of feeling, at least the core of the brain, or the white medullar mass, is sensitive everywhere. Nonetheless, every feeling can be considered in two ways: in the very place touched by an outer being, and in the centre shared by all the nerves, namely in the brain; because every sensation, or at least what we commonly call sensation, occur in the brain, and without it can not be understood. If the free connection between the brain and the nerves is destroyed or broken, the external impressions acting on the latter will not result in any sensation. What teaches us that every change occurring in the nerves is transferred to the brain. This is the reason which allows us to claim and establish for sure that all the impressions exerted on the nerves converge in this inner organ, spreading along the neural tissue along the entire nerve from its beginning to its end nerve. This is why the brain, considered to be the common medium of all sensations and feelings, has long since acquired the name of *sensorii communis*; and the nerves can, in this respect, be regarded as true cords guiding all sensations.

432. — If the nerve feels at the point where it is touched by an external being, what is doubtless,[55] then it can not be reasonably understood that it may have ceased to feel as

55 Experiments clearly convince us of this fact, because after separation of the nerve together with the muscle it enters, its irritation results immediately in a contraction of the muscle. Galvanic experiments are the most obvious proof of that.

soon as its connection with the brain is broken. Clearly, sensation in both cases is the same, but in the latter it ends in the part that experiences sensation; it is not transferred to the brain and the rest of the feeling system and, therefore does not belong to the whole *individual* which, therefore, is deprived of awareness of the sensation. So what we in common language call feeling or sensation is rather cognition, and cognition is proper to the whole *individual*, though having its source in one part of it. We identify the seat of all cognition in the brain, because in this organ accumulates all the nerves which come into contact there, and without it no feeling can become universal. And, therefore, more than for any other reason, we call the brain a mental organ.

433. — This is how, with the nerves being the extension of the mental organ reaching to all living parts and organs, the most universal way of merging into inseparable unity is created, as well as the root of cognition which the mind can acquire regarding the existence and condition of the organic parts that the nerves reach. The nerves are, *firstly*, the cause for which the mind, touching the body parts via the nerves, recognizes those parts as its own and belonging to it. So all the organs are connected via the nerves in the brain and, reciprocally, the brain is connected with them all. Cutting through or tying up the nerves in any body part does not mean, in the strict sense, to destroy sensation in that part, but rather to abolish the feeling of this part in the brain, in other words, its cognition; it means to cut through bonds and prevent contact with other organs, in short, to isolate its

life. And this is why in plants, as not equipped with nerves, every part lives, so to speak, a separate life; the suffering of one part can not be easily shared by another part or the entire plant. None of these parts is connected to other similar parts, nor can it share their suffering, none feels their presence and every one lives, after the death even of all the rest, as long as it has maintained its connection to the trunk through which it receives viability. Even this connection is not so vital, because transferred to another trunk or soil, as long as it can receive viability, such part can continue to live. The same thing happens with animals who either have nerves or in whom the nerves are not connected by the brain or the spinal marrow into one system.

434. — Because all the nerves are connected either directly or through the spinal cord with the brain, Anatomists and Physiologists say that all the nerves have their beginning in the brain. It is equally possible to say that the brain is an accumulation of all nerves and that it is formed from their connections and extensions, all the more so that there are no creatures with no nerves, and there are such that have nerves but no brain. But both of these ways of understanding and interpretations are one-sided, and it is far better to consider the brain and nerves as one and the same body, as one and the same inseparable organ whose boundaries are the same as the whole machine. This most natural way of depicting it will help us understand many neurological phenomena. By such prolongation and expansion of the organ designed to sense, feel and understand external objects, the

points of its contact multiply infinitely and, consequently, its capability to feel and sense intensifies, becomes *varied* and improves relative to the multiplication.

435. — It is clear from this unity of the entire nervous system that every impression taking place in any of its part can not be confined to this part and be enclosed in it, but must be shared by the entire system; as we see, the impression made on one point of the muscle is followed by contraction of the whole organ and would trigger the contractions of all muscles if they were more closely connected and formed a unity. And all impressions imprinted on animate beings are either mediated by viable or non-viable matter; the consequence of the former is both organic elaboration and dissipation, while the latter is largely dissipation, and the latter is the most common. The object impacting the nerves must necessarily be of the same type: it will be the type of matter which that the nerves will absorb; or the type of matter that will exert its effect only on the nerves via physical forces specific to themselves, and thus will more or less excite organic counteraction, but which in itself will not convert into neural matter; in short, a type of matter which is going to more or less detract the neural matter, but will add nothing. Nonetheless, in both cases, because the organic process develops uninterruptedly in living nerves, each body exciting the nerves in its own specific manner shall produce an order proper and characteristic for itself and, both in elaboration and dissipation of the neural matter, shall identify its own relation to the nerves and in this way, it will be felt and

recognized. So every special feeling and recognition is nothing else but *specific* and *proper* elaboration and dissipation of neural tissue, though what it depends on is hard to tell. And the more external sensations the nerves elaborate and dissipate, the more we have *emotions* or *representations*.

436. — It is not properly stated that the habitat of all representations or feelings is in the brain; because it is rather to be found in the whole neural tissue, though the nerves converge in the common centre, that is, in the brain. Just as it would be wrong to say that the habitat of all blood is in the heart, because it is rather to be found in the mass of blood vessels; but the heart is the common centre towards which all the blood converges and from which it exits. Experiments have shown that sometimes very large parts of the brain could be lost due to wounds without losing the imagery acquired beforehand, neither the power of acquiring new ones; what would, however, have to happen if representations had their seat or, as it is commonly claimed, if they were painted in certain parts of the brain. To appropriate a cognition or representation or a series of interrelated representations it is to elaborate or dissipate the neural tissue in a certain specific manner; in other words, to give the organic movement that constitutes its life that or other direction. And if the nerves often elaborate or dissipate or work in one and the same way, then they will finally be completely elaborated at a specific rate, in this and not another order, and in this and not another manner. Therefore, whenever they are abandoned, that is, focused on inner sensations, they will

work rather in this and not another way and, therefore, the imagery attached to this manner of operation will truly be our own. And then, we usually say that we are capable of doing something; this encapsulates the mystery of our way of acquiring representations and skills.

437. — If there is only one power acting on the nerves, then they will be occupied with only one kind of sensation or one kind of movement; this movement is simpler and more accurate and, therefore, the feeling is clearer and more perfect. And if several powers work together, then these actions, being the forces resulting from them, stir up, blur or bear each other. Then the feelings are blurred, vague, and often from quite different those which should have presented themselves. Then, we either do not acquire any representations or those we acquire are inaccurate and accidental. Hence, the representations acquired separately and one after another are more accurate, and such is information they embrace, therefore, the less representations we have the more pure they are;[56] hence, it is no surprise that the stronger impressions and representations destroy and blur the weaker ones; hence, finally, why the weak impressions just after the strong ones do not give birth to feelings; hence, finally. Each

56 Images painted in the speech and poetry of early and uncivilized peoples were thought to be strangely strong and accurate. This is a very natural phenomenon, and the more we will progress in sophistication and enlightenment, the richer we will be in the images and representations, but they will be less clear and strong.

unpleasant feeling can be eradicated and exterminated with a stronger one.

438. — The *senses*. All external sensations of the nerves occur in the so-called senses. Nowhere is the neural tissue exposed naked to the effects of the objects around us, but it is uniformly covered with coatings, therefore objects can not touch it directly. Nonetheless, some of these outer coatings are so formed that they constitute real organs so disposed that only certain beings or motions can penetrate to the nerves only through them. Thus, the entire neural tissue can receive some types of movement and, consequently, sensation and cognition only via such organs. And so, the sensation of light reaches the neural tissue only through the optical organ which constitutes the eye; the vibrations constituting the image of voice only through the ear, etc. Such external organs are called senses.

439. — The vital part of every sense is the nerve and the vital function is the sensation. And although this term originally signified only the sense of touch whose habitat is actually in the entire skin, or on the whole surface of the body, but today we mean by this expression the recognition of any sensation felt by on any nerve. The sense of touch serving the entire skin is the strongest and the most perfect at the fingertips, which we use to find out the volume of bodies, their shape, hardness, fluidity, temperature, weight, softness, smoothness, and the like.

440. — In places designated to be more sensitive to touch, nerve endings end with buds, increasing the number

of points of contact with objects. The buds are covered with *Malpighi* glue and cuticle, without which any touch would be painful. Therefore, objects which excite the sense of touch are not in contact with the neural tissue itself, and, consequently, can not be absorbed by it, just grant it some physical sensations, such as: motion, resistance, may add or detract caloric, and all that more or less at a given time.

441. — The organ which, from the viewpoint of composition, resembles the touching organs is the tongue, intended to discern tastes, though other inner parts of the mouth can partially discern it. Nerves on the surface of the tongue, designated for this recognition also end with buds; though it can not be said that touching as such is taste, as taste can only be felt in beings soluble in the saliva, and therefore, small particles can penetrate to the neural tissue. This property serves almost all organic combinations: acids, alkali, salts and some earths, metals and metal oxides.

442. — The objects of smell may be only bodies which dissolve in the air or partly escape into the air at normal temperature and become steam or gas. If the normal temperature is not enough, slightly higher may suffice, and such bodies will only exude smell when heated. Those that turn into gas or vapour only when treated with the most violent fire will never exude any smell, and such is the majority of metals. Some bodies, which are odourless by nature, can exude some volatile element, and such odours depend on the essence and amount of this element. Such are almost all organic beings, especially living organisms. The seats of the

organ of smell are the nostrils, especially the septum where the olfactory nerve, serving the sense of smell, spreads most abundantly.

443. — The entire structure of the organ intended for the sense of sight is that only light penetrates into the optic nerve. The light from the glowing or illuminated bodies paints their images at the bottom of the eye. The bottom is covered with a nerve that forms a membrane and senses the whole luminous image. Thus, the eye is a true optical organ, shaped in such a manner that the light coming from the glowing or illuminated body gathers at the very bottom of the eye and thus forms a perfect picture of the object where the optic nerve expands and multiplies the points of contact with the light.

444. — Hearing is the feeling and understanding voice and all its variations; and to explain its theory it is not only necessary to know perfectly the design of the ear but the theory of voice itself. Sensation and distinction of voice takes place in the auditory nerve which is to be recognized through the vibration of the moisture in which the nerve extends and ends. So in addition to the vibration of that moisture, no other sensation reaches the auditory nerve.

445. — All of these listed organs, commonly known by the name of external senses, in their design obviously possess a great intention that either only certain objects, or a certain kind of their activity or motion, reaches the neural tissue. This is why representations, or cognitions acquired through senses differ according to differences in the sensory

organ, and one and the same body, which can act upon two or three senses at the same time, is felt and recognised by us from two or more aspects, which we call properties of the body.

446. — All these different sensations sent from the same body through different senses, and therefore different, converge and accumulate in the brain where together the image of the whole body and all its properties is formed. And since such individual sensations and cognitions can either be received together or individually, therefore through this system of senses we are not only acquainted with the whole body and its individual properties, but we learn from experience to consider these properties as characteristics on the basis of which we create separate representations. This gives rise to the so-called abstract images, so the beginning and the whole existence of these images has its cause in the system of senses.

447. — *Internal senses*. The Physiologists, having found perhaps a less proper name for them, point at nearly all instances of agitation of the mind, whose true organ is the brain itself. Between those, they grant the first place to concept or cognition; which of course means the same as representation; which occurs not in the brain itself but also in sensory nerves, or rather in the whole nervous system, as has already been shown above, and so, they have been erroneously attributed to the brain. Another inner sense is *attention* (*attentio*), which is nothing else but attaching and limiting the power of senses to a single object or one of its

properties. In fact, we can never perceive at once more than one object or its single property, because the brain can not be preoccupied with several types of agitation simultaneously, but because impressions often occur quite quickly one after another, the transformations in the brain quickly blur each other. Distancing one and extending another constitutes true attention. If there are several impressions acting upon us, then one resultant is born of such a convergence of forces, and thus the excited representations are just such. Attention, therefore, is actually a resultant of a stronger or longer action of one object at a time; such an influence is naturally stronger, this is why it blurs and abolishes all others. It is sometimes the action of the will, or often perhaps taking place regardless of the will; there are objects striking us so hard that it is beyond our power to draw attention away from them. *Imagination* is similarly regarded as an inner sense that is, the power of picturing objects which are not actually present, and binding such images in a new and unusual way.

448. — The power of recollection of past images is called *memory*, and is also attributed to the brain. Nonetheless, that power, as well as representations, is also a property of the entire nervous system; indeed, as we will see below, it extends to other organs, too. *Judgement* (*judicium*) is a new representation resulting from two or more others compared. And if many images or entire spectrum of imagery is scrutinized, then a number of judgements is formed which can be compared to one another as representations. Such a complex

activity of mind is called *reasoning* (*ratiocinium*). And this most noble power of the mental organ makes the mind the most valued human property and his prime glory. But this power, as well as other organic powers, varies in different *individuals* depending in each case on the condition of the organ in which it is present.

449. — But one of the most important mental powers is the will, that is, the property of animal beings by which they can evoke memories and renew images from the past, and perform the movements imagined in the mind. This animal power seems to have its seat in the mental organ itself, at least it originates in it, and it spreads through the nerves up to the organs of movement, i.e., muscles, and therefore, is founded on the unity of the entire system; what follows is that every change occurring in any part of it does not end and there, but must be shared throughout the system. Such as all the movements of the final nerve endings in the sensory organs reach their common confluence, or mental organ, through the nerve threads; similarly, agitation of that organ travels through to their final ends through the same threads. With the help of the nerves, all the changes which occur in the organs reach the mental organ, and from there, they travel back again to all the organs and parts which the neural tissue reaches. And so, all the changes in the organs and senses converge and reflect in the mind, and all the agitations of the mind reflect in the organs and senses. And since the nerves are strands of cerebral mass reaching up to the organs and the smallest parts of the animal machinery

and spreading out there, and in the brain they just converge, so any change that happens at the ultimate end of any of the nerves will not spread onto other parts of the body until it has passed through the mental organ. Now, such movements of the organs which follow the agitation of the mind and, corresponding to them, ones are called *agitations* of the *will*: that is, they originate in the mind itself or are transferred to it through the nerves.

450. — *A closer consideration of theories of representation*. From what we have so far said about representations and their origin, it follows that we owe them to all the activities and influence of external objects on us and, therefore, without those activities there would be no representations. Consequently, we should agree to the commonly accepted assumption that all imagery is acquired. The answer to the question how external things are imagined in our mind has already been provided (436). Finally, the simplest answer to this question is as follows: they can not be imagined otherwise if not as acting on and influencing our nerves. And this action can be different only due to viability or due to other forces proper to matter, such as: affinity, motion, resistance, densification or thinning, addition or subtraction of caloric and the like. Entities acting in the former manner could be assimilated, and thus, dissimilating the neural tissue, they could themselves be transformed into it. But this way of working can take place only in the nerves because, *firstly*, the nerve endings being in all sensory organs covered with external objects do not come in contact with them directly;

secondly: the greatest part of the objects acting upon us through our senses is non-viable. True, there are those that act on us from a considerable distance, for example, the glowing celestial bodies, all lit or vibrating bodies making sounds and the like. And in this system of senses through which we can perceive the most distant objects there is an enormous benefit: that by simply experiencing the action of beings which do not touch us directly, we are connected to the vastness of the physical world, and thus, we can apply our nerves to its system and more or less understand it.

451. — And so, the action of objects on our nerves without introducing matter that could be transformed into their essence, but only the force acting on their mass, may accelerate or slow down the organic process present in them, or change it this way or another. And in either case, the external beings do nothing more than maintain or in various ways change the organic process of the nervous system. Therefore, certain sensory aspects of our nervous system exerting impressions on us are the ideas and representations we possess. To renew an idea or a representation often means to repeat the same manner of elaborations and dissipations and make the nerves live in this and not another way. And whenever the same manner and order of nerve activities is renewed, we will feel, or we will remember the objects that once had brought the same feeling. Such a renewal can of course take place also in the absence of the object that had originally aroused it. Since we have to continue to act as long as we live, we must necessarily act in some way, and the viable matter

contained within us, which awakens the activity of the organs, may most easily awaken what is already proper and ordinary to an organ.

452. — It is clear from the above that images, representing a certain type of neural activity, are in every case a resultant of action of the organic force and the forces by which the bodies act upon it, and therefore, they do not express the object that awakens them, but rather its relation to us. Hence *Berkeley* was right to understand that no image of ours is similar to the object that awakens it. But, on the other hand, the true good of man does not require more than becoming familiar with the relation of external things to himself, and their interrelations which may concern him. This covers all the physical and moral knowledge that is truly useful. Conjecturing the essence and he true nature of things must necessarily lead to errors and perplexities; for the penetration and comprehension of the essence and the true nature of things is not inherently a human attribute.

453. — Imagination or representation is not the essence of a thing, but an expression of the ratio of forces through which this object acts to the neural organic force in the nervous system; and these forces can not be different than the ones that serve matter in general and make it active, therefore physical or chemical. Let us look at it in examples. If I bring my finger so close to a flame that I burn myself, I clearly have a strong sense of fire. After observing what happened with my finger, I can see that the flame, where it touched my finger, has partly or completely dissipated

chemical combinations between the flame and the organized elements constituting the finger. I know anyway that such is the way the fire acts on organic beings in general. Hence, I submit that the feeling and imagination of fire, derived from touching a flame, is tied to disorganization and chemical changes which this entity aroused or caused in my finger. Take your finger away from the flame, and the same changes will persevere for some time, and the sensation of fire attached to them will last, although the flame has been removed. Hence, other chemical activity equally strongly and violently disorganising, such as that of alkali, some caustic earths, metal peroxides, etc., give rise to a similar feeling of burning and closeness to open flame. So if I bring my hand only so close to the fire so that I merely feel pleasant warmth, I ask myself if then the same fire acts differently upon me? Of course, in the same way, but in lesser degree, so both feeling and the imagining warmth are attached to certain chemical changes in the neural tissue under the influence of caloric.[57] Other bodies, acting on the neural tissue through other kinds of forces, will be similarly known by type and degree of changes specific to themselves. The same comments can be made about taste. If one takes, for example, sulphuric acid and placing it on the tongue, this strong acid, by clearly chemical action, will dissipate the part of one's tongue which it has touched. When I have

57 See § 82 where it is shown that superfluous heat is indeed conducive to dissipation.

dissolved it in water so that it only arouses the pleasant feeling of acidity, of course, I did not change the way it acts, but only weakened it by dividing it into parts. So the taste, be it sour or any other, can be a chemical change, aroused in the nerves of the tongue. It can be a chemical-organic change because the combinations of the latter type can not act only chemically. The sense of smell is quite similar to the sense of taste. Ammonia, for example, sulphuric acid, hydrochloric acid cause visible chemical changes in the organ of smell, therefore I postulate that other smells and fragrances of the same kind cause similar changes, and in this the sense of smell is completely in agreement with the sense of taste over which it presides and which it assists.[58] Smell, be it nice or revolting, warns us of the salutary or detrimental effect of beings which are to serve us as food and repel us from its use or attracts us to it.[59]

454. — However, not all sensory organs of touch smell and taste work in a distinct manner, e.g., only chemically. The action of some is, of course, simply mechanical: we have bodies in motion, resisting those that are smooth, hard, rough bodies, and the like. Some powers acting on the nerves of smell and taste act evidently through viability and

58 It is reasonable to assume from these comments that representations and all the actions of the mind inspired by the vigilance of the senses are proper for elaboration of nerves.

59 If an entity acts too much too strongly chemically or organically-chemically and tries to dissipate organized matter, we are repulsed from its use as a power that can dissipate the innards.

directly on the sensory nerves, and through them they increase not only the chemical but also the organic process throughout the system, which is proved by rapid and almost instantaneous coming round and refreshment under the influence of strong aromas, vinegar, wine, and food.

455. — The sight, which lends us the feeling of light and colour, seems to depend on another kind of transformation, or at least in the eye no chemical changes are visible. Although the sun rays, concentrated by glass or burning mirror may evidently damage and burn the organic parts, nonetheless this disorganization is without any sensing of light and seems to depend on the concentrated or extracted caloric combined with the true feeling of fire. On the other hand, the black colour of *choroideae*[xviii] suggests that the light collected at the bottom of the eye remains in it, and thus absorption of the neural tissue is possible, though our ignorance of true nature of light may neither confirm nor contradict this presumption. In any event, whether or not the light is absorbed by the nerve pulp, or it just acts on it through its course or through another power, each colour must act in its own way and thus produce its own images when, at the same time, the neural points in which these changes occur in a way draw a figure of the body on the nerve and provide us with some notion about it.

xviii The vascular layer of the eye is situated between the retina and the sclera.

456. — In the ear a voice is born infallibly by vibration of the moisture filling of the cavities of the *atrium*, the *cochlea* and *semicircular channels* and voids in which the auditory nerve expands and ends. In this sense, the vibration of such moisture does not seem to work in any other way than by inducing a similar vibration in the nerve itself, thus acting in quite a mechanical manner.

457. — There are bodies and their properties whose representations are acquired with one of the senses, and there are those which impact two or three senses together, and then, the acquired representations are complex. Finally, representations acquired through a single sense are straightened and perfected by another, and even the senses themselves are perfected and improved thanks to assistance and direction they receive from others. And so, we judge the movement, distance and the size of bodies primarily by touch and, in this way, we not only clarify the images obtained in the eyes, but we improve the skill of judging only by sight, although the evaluation of size, movement, and distance of the body by sight only is often mistaken. Moreover, representations and images can be simple or complex, according to how objects act upon us, either in a chemical or physical way, or in two or more ways together.

458. — In order for an external object to act upon us and produce an image or representation, it must necessarily have some strength and durability because the blurred movement hardly reaching the sense organs does not reach the mental organ and, therefore, is impossible to conceive.

For this reason we do not discern the voice from far away; we do not see objects too small or too distant; we do not see bullets flying past us, and we can not judge the shape of rapidly moving bodies. In addition, each impression is weak only momentary, and immediately blurred by other, while a strong one lasts for some time corresponding to its intensity. For this reason, the burning torch twisted around produces a sensation of a glowing circle, and this is why seven elementary colours circled around rapidly give a sensation of seeing white colour.

459. — From the preceding lecture on representations it follows, *firstly*: that since the weak sensations (458) impacting the senses not reach the mental organ, they must be weakened relative to the distance from the place where they originate. Hence, we understand why the mind has no knowledge of the changes occurring in other organs until those changes have acquired a certain power, why it exerts less power on the distant parts of the body than on the closer ones, etc. *Secondly*: because our feelings and representations are not expressions of the very nature of things (452), but only of its relation to us, this relation must obviously change, not only due to the difference between the things themselves, but also due to the changes in our *disposition*, that is, according to the condition of our nerves and the organization of the senses. And since this condition depends on the type of person, gender, climate, temperament, the state of health and the daily state and present degree of burdening of the machinery, it is no wonder that the same thing arouses

different feelings and sensations in different people, or even in ourselves, depending on time, age, and current disposition. Hence, there is no universal law governing tastes and defining real beauty. Hence, the fragrance, sight, and reminiscence of food may be delightful before dinner and unbearable after we have eaten. Hence, every item after use becomes indifferent or unpleasant. Hence, we often reprove the same thing we may have been enthusiastic about only a few days earlier.

460. — *Powers of the mind*. Representations acquired by the senses and originating in the senses are, so to speak, a shared property of the senses and the mental organ; other mental powers commonly called powers of the soul are the property only of the latter. Are mental powers the property of the whole brain mass, or perhaps every mental power is the property of a different part? Are they all scattered all over it or perhaps collected in the middle, ordinarily known by the name of *sensorium commune*? Or, what amounts to the same thing, is the whole brain only a single mental organ covering all its powers, or is it a collection of several organs? Imperfect knowledge of the brain and its mode of operation, unfeasibility of observation of all its parts while this organ is alive, the difficulty of conducting experiments, which reaches improbability, prevent us from providing straight answers. Even different Physiologists indicated different parts of the brain as the habitat of the soul and *sensorii communis*; and all of them had equal right to do so; whenever in the study of nature both experiment and experience are

incapable of determining the right answers, all conjectures are equally good.

461. — However, when dissecting the brain mass, we can see that it is not homogenous everywhere, but composed of different complex forms. This makes us speculate that all this huge mass is interwoven from various neural organs which can be the seat of various powers and agitations of the mind. The simplest perceptions convince us of the fact that the brain itself is the habitat and the true organ of all actions and movements of the soul, that its existence and its entirety is an inevitable condition for thinking and acquiring all mental activities, while animals need only nerves or spinal cord to live and grow. Sometimes, in the absence of brain, or if it is damaged or not working, life does not cease immediately. But the action of the mind and the feeling of one's own being at that moment ceases in each of these cases. In addition, only some animals are equipped with a brain, while all others have nerves and a spinal cord. In that latter, animal life, sensations and movements are complete, but there are no mental powers which grow and improve in the same ratio in which the mass of the brain grows. In people, who excel in talent and power of mind, the brain is far more extensive and perfect: not only the perceptions of Anatomists and Physiologists, but even of the common people will prove this thesis.[60] This remark shows even more

60 Some scientists, comparing the volume or the weight of brain in various animals claim that animals have larger brains than humans;

clearly that the powers and agitations of the mind are organic. This is a stable and unchanging law in the whole organic system of the world, that the functions attached to a certain organ are the more perfect the more abundant the organ itself is. The woodcarvers in the past knew the truth very well: that knights and athletes with their huge bodies and impressive muscles had small heads, while those appointed to rule the world had enormous skulls.

462. — Therefore, if the brain is indeed a collection of various mental organs, then the perfection of each of them must in particular depend on the abundance of the cerebral mass that constitutes them, and on its perfect formation. In view of this, it would not come amiss, nor would it be possible to consider and record the composition and shape of the head in persons whose particular power of mind excels others; because such consideration not for itself, but connected with the anatomical disassembly of the brain, may in time lead to better knowledge of some mental organs; though it is doubtful that such a science might in fact bring the benefits it promises.

therefore the mental powers are not in relation to the cerebral mass. But who can not see that such comparisons are wrong? Because the mass of the brain in different types of animals should be considered relative to the whole organic machinery, and therefore to the vastness of the rest of the nervous system. So, whichever animal compared to another has a larger brain in relation to the rest of the nervous system, the mental powers of such an animal should be stronger. As far as I know, only *Sömmerring* considered the ratio of brains this manner.

463. — We have said that the powers and agitation of the mind should be considered to be truly organic, and that these activities must be carried out in specific and proper organs, and these organs must be in the brain because all the powers and agitation of the mind are undoubtedly attached to the brain. Moreover, as all the properties differentiating the species and genera of organic beings depend on the differences in their organization; as those organisms continue to gradually perfect within the general range of beings; addition of new organs gives rise to new powers and qualities; consequently, powers of the mind should not be considered otherwise. They constitute an activity and manifestation of life of certain organs, which in some beings are completely absent, while in others differs in degrees of perfection and power.

464. — Between the mental powers, such as: images and representations, memories and, to a certain degree, also thought expressed in words, some can be seen in many animals endowed with a brain; though their power of reasoning is very limited, and far from the same power in man. *Imagination*, nonetheless, seems to be exclusive to humans; it can be justly conjectured that there is an organ in the human brain devoted to imagination which other animals do not possess. Similarly, only humans conceive the existence of the highest Being and honour it; even the wildest peoples have their religions. This universal worship of the highest Being must be primed in the special power of the mind, also proper only to man; I say, it is the power of investigating

and exploring causes of phenomena and probing the invisible springs of the visible effects. Having assumed such power, of course, consideration of the world and its order must necessarily lead to understanding the first cause of such an enormous and astounding outcome.

465. — But accepting as true that the brain is a collection of several mental organs on which various powers of the soul (with respect to the physical part) depend; I would never have dared to mark their number, following *Gall*, and point out a certain and seat for each of them; although perhaps diligent consideration, combined with careful and long anatomical dissection of the brain, will one day bring us closer to this knowledge.

466. — In addition, the brain may indeed be a collection of several organs but always closely united; this is proved by unbroken character of the cerebral mass. The activity of any one of them must cause the activity of another; various manifestations of mental powers may result from different combinations, and from various degrees of these activities. This is why is it wrong and unnecessary to designate as many separate brain organs as there are powers and agitations of the mind; it is far more daring to indicate a separate and certain habitat for each of them.

467. — Moreover, the power and speed of brain activities can present the same mind powers in another form and transform one into the other. Feverish with wine, love or anger, even the most reasonable man is not himself. It can not be otherwise, according to the assumptions of this

lecture; the mental powers are organic activities; although the foundation of their power and their perfection lies in the perfection of the organs themselves, but the activities must be designated and covered by all these conditions by which other organic activities are designated and covered by, namely: they will depend on temperature, on the influence of external beings that surround us, and on the abundance and nature of viable matter subjected to processing. Most of the entities acting directly on the nerves are non-viable, therefore the most abundant source from which neural tissue is elaborated is blood. Thus, during a stronger brain activity, we can see a head becoming warmer and blood flowing profusely to it, this is why after completing digestion and elaboration of new blood, the mind is most suited to work; this is, finally, why, the rate and power of blood circulation obviously affects the state of mental activities. The same is true of the abundance of arterial blood in the head; and is an experience which taught us long ago that people with long necks or excessively tall is usually weak in the head. In fever, due to the abundance of blood flowing to the brain, the activity of this organ is sometimes increased to such an extent that it turns the silent and incomprehensible into smart, brave, and eloquent. Similarly, love fever has turned many into the poet. Anger has dictated poems to *Juvenalis*.[61]

61 *Facit indignatio versus* (*Anger inspires the verse*) [from Juvenalis' *Satires*].

468. — Continuous use and exercise of an organ perfects and strengthens it, making it more active; it is often detrimental to other organs acquiring viable matter from the same source. And so, the powers of the mind, just likes all other organic powers, improve and strengthen through frequent use, but this is detrimental to the powers of other organs. This is the main reason why the elaboration of digestive juices and, consequently, digestion is so weak in scholars. Therefore, during intensive work of the head we often see cooling legs, by the same token long walks and physical exercise calm overly excited powers of the mind and return them to decent mediocrity.

CHAPTER XXXI

OPERATION OF THE WILL. VOLUNTARY MOVEMENTS OF MUSCLES.

469. — The special power of animal beings by which they perform movements designed in the mind is called the *will*. According to this assumption, this power is mental, and therefore, its habitat must be in the brain. Nonetheless, it exerts itself on the muscles which contract candidly; therefore a change which has occurred in the mind must be flowing into the flesh and be the cause of muscle contraction. It can find no other way to flow but through the nerves which, exiting brain, separate and end in the muscles. And because every neural activity can eventually be brought to the senses, so the sensation aroused at the ends of nerves continues until it reaches the brain and, conceived in the brain, extends back until it reaches the end of nerves.

470. — Great share of muscle contractions which we attribute to will is the effect of concurrent external sensations which, transferred as far as the brain, arouse images which, reflected from there to muscles, cause the contractions. Just as every stimulus exerted on the nerves produces a sensation, every stimulus exerted on the flesh brings about contractions

or vibrations. And because the nerves are the conduits of all sensations, the effect must be the same in each case, regardless if the exertion is directly on the muscles or on the nerves which would transfer the stimuli to muscles. *Because all representations and images are acquired, and originate in the influence of external objects upon us, by the same token all movements are also acquired.*

471. — But such is the composition and original formation of the body, in short, the mechanism of animal organization, that every, impression and every instance of exertion of force on the organism, in accordance to evoked pleasure or repulsion, arouses beneficial movements, intended to diminish and repel bad or harmful things, and to bring closer and appropriate useful and pleasant things.[62] The first stimulation of these movements is concurrent with the acquisition of a representation and the action of the objects that produce them. Every time the representation is refreshed, the latter are refreshed, too, and return with every renewal of the representation or image without the presence of the imagined objects. In this way we acquire both certain representations and movements which are originally mechanical, independent of our will, but which we finally learn which ones we can refresh in the same manner as we do representations and images. And, in the course of learning, the mind slowly

62 Everything that works towards and in keeping with the organic force is pleasant because it helps its achievements, while everything that works in the opposite direction is unpleasant; because it attempts to destroy that achievement, it strives to abolish her or weaken it.

acquires powers and skills in recalling them and refreshing according to need.

472. — Movements, so called voluntary, are a real skill which we acquire from the very beginning of our existence, and the muscles form and strengthen through these movements, just like all other living organs. Thus, all the so called voluntary movements are firstly done unaware; in the beginning we can not possess awareness, but we acquire it after a long experience, and even then we do not know which organs we use to perform those movements. If anyone who was unfamiliar with Anatomy uncovered all the muscles of our body and asked himself which are applied to perform which movements, he would certainly be unable to answer this question. So, everything in us is a science funded on the property of the organism itself, because the nervous system is elaborated and organized in accordance to stimuli it receives. Proof of this is the different way of feeling and judgement of people living in different nations; more evidence is in borrowing addictions, habits, gestures, the way of thinking and manner of speaking from people who surround us. Finally, the proof of this is a mechanical and unrestrained tendency to imitate, which is often so strong that we feel forced to indulge in it, and which is most powerful in children because their nervous system is yet to adopt a certain manner of elaboration and properties depending on it.

473. — In the entire course of life cycle, we can see movements and agitations excited in our bodies and in other animals, such that take place without our thought and emotion,

indeed, even against our will; we can see movements occurring without thought, often so beneficial and wise that what remains is only to wonder about them. Why, for example, a newborn baby, who yet does not have any idea about anything, and can not have his own will, takes an offered breast in his mouth and sucks, then swallows the sucked food? Will we call it agitations of will? Anyway, this is that we call them later. How can one want an unknown thing and to obtain it engage in unknown movements? Is not it simply a result of animal organization in which some external powers, acting upon the whole organism or some parts of it, instigate a certain kind of movements? After all, all these movements directed at provisional or continuous welfare of the organism are often so relevant and so rational that they surpass not only all our skill but also our capacity to understand them.

474. — *Instinct.* And these are the salutary movements which have long been noticed by the commoners, and given the name of *instinct* or *inspiration*, as neither dependent on our cognition nor, primarily, on our will. Can knowledge or will be attributed to behaviour of animals that avoid things harmful to them, or do what is useful to them, although they do not comprehend the purpose? Whose example, advice and knowledge do they follow to recognize poisonous plants among their fodder and manage to avoid them? How do the young, inexperienced animals recognize the enemy at first glance? And have did they learned the manoeuvres by which they can be protected from the enemy? Whoever manages to avoid a missile unexpectedly thrown at him with

a swift move of his body, has he devised a plan of that rapid movement and turn? Or is he capable of banning the missile from hitting him once he notices it approaching? Hearing a scream or thunder nearby, who will forbid himself to turn round and look in that direction? At, finally, who leads huge flocks of birds from northern to southern countries when winter approaches? Who brings them back to the old place with the return of the spring? In short, anyone who looks with the attention and without prejudice at the behaviour of animals, insects, and even plants, will perceive everywhere in the foundations of their organization the most ingenious, the wisest, most perfect movements leading to their *individual* purpose or the general purpose of nature; and this surpasses all wisdom and knowledge, not only of these creatures but also of man himself.

475. — All these movements of organic entities, striving towards satisfying the intents of nature or towards *individual* generic good, are the result of relationships which arise between the organizing powers either in universality or in particular cases and other matter moving forces. These relationships are largely unknown to us, so their instances are inconceivable and astounding. Therefore, animal movements striving towards satisfying the general or *individual* intents of nature are not so much owned by these creatures within which they occur, as they are by the universal and first cause which nourishes the entire nature, upkeeps the entire world, which had originally transformed matter into organic form, and which perseveres until this day in all

organized beings and in the whole animated world, and organizes it without interruption, which — let me put it this way — had inspired the organized matter through which it operates and manifests its properties, and which the ancient Roman Poet considered to be the soul vivifying the entire world.

Spiritus intus alit totamque infusa per artus
Mens agitat molem et magno se corpore miscet[xviii]

We, on the other hand, making such movements customary through frequent repetition, feeling their salutary effects, learn little by little and try to turn them into a habit in order to renew them according to our liking and similar intentions; though we most often never fulfil those intentions.

476. — Nature has located muscles in such a manner that they are perpetually aroused by some external, or direct internal stimuli, so that they have to continually contract and relax; they are less sensitive to sensations reaching them through nerves as they are much weaker than the former. Those muscles are known by the name of *involuntary*. Such is the heart and the entire muscular membrane of the arteries, such is the whole digestive tract and all the breathing muscles. Contractions of these muscles in response to perpetual,

[xviii] *The spirit within nourishes, and the mind that is diffused throughout the living parts of nature activates the whole mass and mingles with the vast body of the universe.* Virgil. *Aeneidos.* Lines 726–727.

specific stimuli is either not the subject of attention, and therefore we can not simply learn those movements, or the stimuli directly exciting those muscles are far stronger than the agitations of the mind which could have been reaching them through the nerves. But if these agitations become violent, then they reach the mentioned muscles and confuse their normal and regular contractions. Joy, for example, fear or anger, accelerate the rate of heartbeat and interfere with its order; focused attention, deep thinking, labour of the mind may hold and delay the rate of breathing. In addition, there is hardly anyone who could not, according to their liking, be able to breathe faster or withhold breath under the influence of focused mind.

477. — And the muscles which are located in such areas where they can not receive any direct impressions will only be moved by the sensations reaching them through the nerves. So it is not the will which must act the strongest because nothing interferes with such action. But if a force transpires accidentally or through illness, but force acting upon muscles directly and powerfully, the will does not have any impact anymore; we see numerous examples of the above in convulsive and spasmodic diseases. Violent movements of the nerves or mind inhibit the influence of the will upon voluntary muscles on to a certain extent, such movements spoil the direction of movement or inhibit contractions of involuntary muscles. We see for everyday that violent movements of the mind not only suppresses or mixes the contractions of the heart, but even contractions of the gutter tract;

this is observed particularly in sensitive people in such phenomena as belching, bitterness in the mouth, vomiting and sometimes lax. It is clear that the generally accepted division made by Physiologists, into *voluntary* and *involuntary* muscles has no justification in the nature of muscles themselves, because there is no difference between the muscles, apart from their location in the body.

478. — *Passions*. All sensations affecting the nerves are connected with pleasant or unpleasant feelings.[63] This unpleasantness brought to the highest degree awakens *pain*, while pleasure awakens *delight*. Such is the property of the animal organization that the pursuit of good and avoidance of evil evokes movements intended to, first of all, achieve the objects of excitement, and to recede and remove the others. With time, we learn these movements and we can, as time passes, arouse them as we please. Hence the will takes two general directions, namely: *desire* and *disgust* or *dislike*. And so we learn slowly, through experience, to judge useful, harmful, pleasant or unpleasant things; and, using free will, we direct our actions with an intention to acquire or remove those things.

63 This pleasure or displeasure in general seems to depend on the following. The *individual* force operates continuously and always in a certain direction only in accordance with *individual* well-being. Any force, wherever it operates, seeking to change this direction, becomes evident as unfriendly to the whole being, giving rise to repulsion and distraction. Any accelerating action of the organizing force in the proper direction gives birth to a pleasant feeling and an attempt to appropriate it.

479. — But the will is powerful enough to arouse pleasant or unpleasant sensations in the nerves, as long as such a sensation is felt in certain regions. If it is too violent, it will act directly upon the muscles, removing them from the influence of the will, like any other violent impression acting directly upon them. And then, this violent agitation of the nerves directing all actions, even the *will* itself, turns into *passion*. Passions, therefore, are nothing but strong feelings, and just as the will, stir up the motions to acquire or remove an object, but those movements are disorderly and violent. The passions which drive us to acquire or achieve something are: *love*, *pride*, *longing for fame*, *point of honour*, *love of the motherland*, *ambition*, *republican zeal*, *greed*, *avarice*, *emulation*, *friendship*, *piety,* etc. The unpleasant passions are: *hatred*, *jealousy*, *anger*, *revenge*, *cruelty*, *grief*, *despair*, *dread*, *shame*, etc.

480. — Because every passion induces a certain kind of agitation, a violent one governs and rules all agitations; these agitations are a language, or rather a picture of passions, a picture understood even by animals. And if a passion is often renewed and it becomes habitual or prevalent, the counterpart agitations become so, too, and they are reflected in the whole posture of a man. This is why a skilled and experienced observer will easily guess from the countenance and body structure what kind of passion rules a person.

481. — In general, pleasant passions do accelerate the course of life, blood circulation, animal warmth and both organic elaborations and dissipations. They are revealed

in a cheerful, smiling face, clear and sometimes sparkling, healthy blush on the cheeks, tendency to chit-chat, favourable attitude, kindness shown to everyone, singing, leaping, and jumps and loud laughter. So stirred up, people try to bring the favourite object closer; thus hugging, joy, shouting and applauding. At such time even the strictest mind is tempered and induced to good deeds; thus forgiveness of hurt and offence, extraordinary kindness, favours, familiarity, confidentiality, charity and the like.

482. — Unpleasant passions are reflected in contrary signs: wrinkled forehead, brows close to each other and directed inward, oblique gaze kept on the unpleasant object or turning the eyes away from it altogether, as well as or pale countenance alternating with flushed cheeks. The beginning of these passions is marked by silence, then there are vicious remarks, reproaching, mockery; a stronger outburst is marked by threat, cursing and pestilence combined with raised voice and screaming; in women and children crying and loud wailing. At such time, the mind is focused on wrongful and harmful deeds.

483. — Passion, therefore, is a demand, a strong desire to acquire or dismiss something; thus decisive actions and enterprise, endeavour, extraordinary exertion of the body and mind if one is strong enough, and the likelihood of acquiring or dismissing something that is a purpose of passion seems to be promising. If the feebleness or poor sense of power show us poor likelihood of acquiring what we desire or dismissing something repulsive, then despair is awakened in

those stronger, while fear, suspicion, silence, and avoidance of all companionship and conversation awakens in those weaker.

484. — Passions, just like all natural events, have their degrees. The weaker ones generate only direction of the will and movement of muscles. While the stronger generate direction and action of the mind; this is why the former can conceal and appease themselves, while the latter usually explode. Violent passions govern the will and the mind and become the true *madness*. It is therefore possible to establish infallibly error that every passion elevated to the highest degree becomes the true madness.

CHAPTER XXXII

CONSIDERATIONS ON THE THEORY OF NERVES.

485. — How do the nerves or will act upon muscles? How do the changes made in their final extremities reach the brain? Physiologists have been wondering about it since the early days, and trying to provide numerous explanations. *Galen*, and along with him almost all the ancient authors, understood that the nerves were nourished by a particular element, or a volatile spirit which is born from the air drawn through the nostrils, and from the viable spirits brought from the arteries to the cavities of the brain, and from there spreads to all the organs. Later, the grey matter of the brain, which by all likelihood is mostly constituted from intertwined vessels, considered by some to be a collection of lumps, was assigned, I say, a separation or elaboration of a particular fluid that was called neural, whose rapid course was attributed to the transfer of representations and images to the brain, and orders of will from the brain to muscles. There were those who considered this utterly sophisticated

and fast flowing liquid to be the light, or phlogiston, ether or some electrical matter.[64]

486. — Some thought that nervous threads were tense strings, and all the external sensations were strikes spreading along the threads, and moving from one end to the other. *Sömmerring* followed the nerves originating from the brain to the walls of cerebral cavities (*ventriculi*); where, according to him, they appeared to come to contact with moisture lining those cavities. He understood that this moisture was a mediator between the soul and the nerves. Others called the unknown cause of all *nervous* activities simply nervous power.

487. — But the assumption claiming that the nerves are vessels encapsulating a special invisible fluid has not been proven by experience and experiment, and it by no means facilitates understanding the neural activity. Moreover, when explaining how the sensations impacting the nerves are transferred from one place to another, we fail to explain the way the nerves feel. The explanation of the first phenomenon does not require separate conjectures, since the thing is proven and undoubted that the brain and nerves together constitute a single organ; they are one and the same

64 This science of nerve fluid was ridiculed and abandoned in later times, though it must be admitted that it is far more reasonable if compared to other theories in this respect.

unbroken inner system and, therefore a change, wherever it would originate, must be shared by the entire organ. In the second conjecture, the nerves ought to be understood to be strings, very tightly strung, and all the mental and neural activities to be weaker vibrations. Notwithstanding the fact that such a tension in the soft neural tissue is beyond comprehension, experiment and experience abolishes this conjecture completely. The nerves, when cut across, not only do not shrink, which in such a case ought to have necessarily happened, but they extend and overlap with one end over the other. If we assume that this vibration travels only along the tense nerve sheaths and in the sheathed pulp is felt everywhere, then we would only interpret the propagation of impressions, like through the neural fluid, not explaining their sensitivity or perception of concept. Finally, such an assumption would necessarily entail that all external objects can not act otherwise on the nerves but through by a mechanical stroke or resistance, whereas we have evidently shown that the influence of objects on the sense of taste and smell is in most cases distinctly chemical, moreover, one can not assume in Physics that a body acting on another would not act involving all its properties together. Finally, the assumption of moisture as an intermediary between the soul and the brain is also not consistent with a good Logic which does not conceive anything between the spirit and body. Such an assumption is not physical and does not make understanding the gist of the concept easy.

488. — If we think about it more carefully, no conjecture or supposition may explain either sensitivity or thinking. Because if we do not understand how those phenomena occur in the brain mass, can we understand better how it takes place in the soul? Or can we understand what may happen in an imaginary entity mediating between the brain and the soul? Finally, if we could comprehend how we think, which is absolutely impossible, I ask in what way this skill would be advantageous? In honest sciences one should not depart from things certain, based on undoubted perceptions or experiments, because science is genuine if it is useful. The most obvious experience teaches us, *firstly*, that feeling, awareness, action, and agitations of the mind take place only in organic beings, and therefore, these are true organic activities proceeding in the same way and according to the same laws as all other of the same kind, *secondly*: that the organ in which such activities take place is the brain and the entire nervous system as a union. Knowing this, we know as much about neural activity as about all other organic activities. Can we better and more clearly understand any other activity of living beings as to the way it occurs? Do we know, for instance, how digestion or any other organic elaboration works? After all, what is important in each of these cases is comprehending the way in which matter organizes itself, therefore understanding the creative power which has originally organized it, and has been organising it until this day. Feeling and thinking, just like the other amazing phenomena of life, are a revelation of this power, and the brain is the organ in

which, under an astonishing form of thought, it is revealed and developed, and even we ourselves are only the point at which, brought to its elevation, it unfolds and develops, subsequently giving rise to an array of inconceivable phenomena of life, only to finally wither.

489. — We shall find out that all the activities of the brain and nerves consist in the action of the proper organizing force exerting itself, *firstly* because the assumptions of this lecture show that every activity taking place in the living creatures is organic; *secondly*, that the entirety and existence of these activities is bound to entirety and existence of the free operation of that organ. Absence, exerted pressure or damage of the brain, damages or halts all mental activities, similarly overstraining, damage or pressure exerted on the nerve, destroys the sensation in the affected nerve, while tying the nerve up only abolishes the union of the affected organ with the brain; *thirdly*, unbroken operation of the brain and the nervous system requires continuous inflow of viable matter, and viable matter is to be found, obviously, in the blood; tying up arteries transporting blood to the brain halts the activity of the entire nervous system; it is likewise halted when blood circulation is halted even for a moment. Intense brain activity resulting from passion or strenuous, prolonged mental activity evidently increases the flow of blood into that organ, which results in redness of the head and the strong beat of its vessels. The increased warmth of the head at that time shows the accelerated organic process, that is, increased elaboration and dissipation,

which is further corroborated by proliferation of excretions, i.e., sweat and urine.

490. — The neural tissue is undoubtedly elaborated from blood, and itself seems to be the object of further elaboration, appearing to be part of the aliment of some organs. Although it has not been proven by evident experiments and, indeed, is difficult to be proved, for many reasons it seems to be close to the truth. Degeneration, for example, and exhaustion of the organs deprived of the assistance of the nerves which have been tied up, damaged or cut across seems to show it to us clearly; primarily through complete change in organic elaboration, than again either through halting or reducing or intensifying the neural activity. Finally, if a nerve is cut across, we can see that its threads become extended, and that the neural tissue convexes at the severed end through which each thread seeps from its sheath. This shows that the pulp gets a slight acceleration in the brain into the extreme nerve endings, and so it flows into and spreads in the organs the nerves reach. It must take place in muscles and in the organs of secretion; it is the muscles which receive most of the nerves disappearing in them completely, and therefore, the action of the will upon muscles must be connected with seeping of the neural tissue and processing it in the muscles.

491. — The brain and the whole nervous system take part in aliment and elaboration of other organic parts, and in this respect is similar to the heart and the entire arterial system likewise taking root all over the body and reaching almost all of its points; the only difference is that the arteries

and vessels branching off the arteries reach all points of the organising matter, while nerves do not reach everywhere. And because arteries, when dispensing viable matter, release caloric, and thus warm up the body at the ratio relative to nourishment, similarly, the nerves dispense their own kind of viable matter, alongside with feeling and dispensing, so to speak, mental life. And that is why the change in the state of neural activity influences almost as strongly and substantially the whole status of life and of all organic elaborations as the change of blood and its circulation does. Therefore, partial or total destruction of the neural activity leads to extinguishing life in part or totally, though not as rapidly as halting the arterial functions.

492. — So if the brain activity is more prolonged and intense when muscles and other organic parts nourished by the nerves rest, the elaboration of neural tissue is far stronger than its loss. On the contrary, if the activity of muscles and the whole body is more intense than the activity of the nervous system, the former must elaborate harder and abound at the cost of the latter. And if this advantage in one or the other system depends on the nature of life, temperament or habit, then prevalence and dominance of one over one another is decided continually and constitutionally. Experience does not say but the voice calls out for such a thought.

493. — Because, *firstly*: the power of muscles and their true force is steadily in the opposite relation of mental work and sensitivity, while the latter is in the direct relation to

mental activity and in the reverse relation to the bodily effort. That is why athletes, knights, hunters, industrious farmers, craftsmen, mechanics, have the strongest and most abundant muscles, boast perfect elaboration, proper digestion and assimilation, while their nerves are insensitive, inactive and hard to move; their minds are dull, and the powers of the soul only slight or none. On the contrary, men of letters out of vocation immersed in the depths of teachings, in thinking and rest, those who perpetually employ sensitivity and maintain a strong passion; that is, all devout and fanatics, those in love, voluptuous, greedy, ambitious, jealous and the like, in whom sensitivity is highly elevated, with exaggerated nervous systems and a tendency to agitation; those have lean and weak muscles, imperfect fluid elaboration, digestion and assimilation only slightest. The human condition, when life is severe and wild, leads to the exaltation and abundance of muscles and secretions; the polished and sophisticated state, artistry, learning and science to the contrary: those lead to exaltation of the nervous system, to exaggerated sensitivity and softness. Both of these states are reprehensible, for the former is the state of barbarism, the latter the state of effeminacy. In the first, a man following the habit and perpetual need of a strong elaboration of muscles, hunts or seeks war or robbery; in the second he seeks all that may arouse or increase his sensitivity, or at least elevate the formation of the neural tissue in the degree to which, once achieved, could be maintained. Such a man likes softness and idleness, he loves romances and theatres where he becomes sentimental over the fate of the unhappy who had never existed, about whom he forgets in half an hour; indulging in gossip and of malicious jokes or lewdness and debauchery. Then, he proceeds to use his head, wondering about different strategies in whist or chess, or indulges in greed and gluttony at the gambling table. The state between the two is the happiest and the most perfect.

494. — The first, the purest and most salutary measure which alleviated the original barbarity of peoples and closes in certain bounds is *religion* which is quite a neural activity, exhibiting before man the greatness of God absconditus, His justice, the severity and goodness all in one, kindling the soul with hope of future life and the fear of its loss. Religion teaches fraternal love, illuminates the imagination with great and wonderful images, and thus leads to poetry and eloquence and through them, gradually, to scholarship and craftsmanship. Religion alleviates savagery and cruelty of warring nations; maintaining his nerves active, it sweetens the farmer's disagreeable work and makes him a thinking entity; in short, it is the most important spring of civilization and social order. Religion is the entire and incomparable happiness and blessing of simpletons.[65] But this most wonderful activity of the nervous system may just as

65 Two are the principles of the social relationship and happiness, namely religion and government. The latter, whatever it may be, is always to the benefit of the mighty, while religion is the consolation of the weak and the unhappy. All the same, there have been contemporary scholars so reckless and unwise that they tried to weaken the faith of the common

well surpass decent boundaries. Piety and reflection of future life so strongly and intensely elevate the activity of the nerves and sensitivity that they alone are enough to soften a man and lead him to effeminacy; not only individuals but of entire nations; as we saw examples in the history of Europe in the times that preceded us, when some peoples without science and crafts, without trade and wealth became effeminate under the influence of monasticism and fanaticism came close to decline or outright downfall. Elsewhere we will discuss diseases brought about by the prevalence of nervous or muscular system, as well as other systems.

people, considering that it was not the people's only happiness. Such a class of scholars is worthy of universal contempt.

CHAPTER XXXIII

HABIT. MEMORY. SCIENCE.
FEELING ONESELF.

495. — Since every sensation introduced by external objects instigates in us a certain kind of activity dependent on organic elaboration and dissipation in the nerves, muscles, as well as in other organs, therefore, if a certain type of sensation impacts us constantly or frequently, some or all of the organs take this and not another direction of activity, or elaboration of viable matter, in that, and not another way. What follows is that later it requires strong forces to give direction to organic activities, and these easily return to the original direction and order. Such a case is called *habit* or *custom*, or *practice*, it occurs in muscles or other organs and *memory* in the brain and nerves. Indeed, these two cases are not so different; habit or practice are muscular and organic memory, likewise memory is practice in the nerves. Custom and memory together cover all our knowledge that is both skills and art.

496. — At an age in which animal organs have not yet acquired the direction or habit, except for the primary granted by the parents, and therefore at the age in which they are

most vulnerable to accept all sensations and impressions, the memory is the strongest both in the nerves as in the flesh, because at that time all sensations and impressions are new, and there are no more powerful ones to extinguish. This is the age of education, because in this age only it is in our power to form the developing organs in a pleasing manner. At this time we can easily learn languages, leaps, music, we give the body the desired posture, practice muscles, and we acquire skills and develop imagination. In short, in continuous action, we elaborate and improve our organs and, therefore some sort of activities, we elaborate them in this and not in any other manner; and this way of action, having become proper and easy, becomes our true skill.

497. — And so, this graduate, decent and skilful development and improvement of the organization constitutes moral and physical upbringing, granting this or another system an advantage, giving our organization such or other properties; though the original seeds of those properties are located in the first formation, and are given to us by our parents. For instance, improper formation in early age can make an organ reluctant to develop, in some organs it can leave a store of opportunities, in others very weak or none; just like by nature we see in some people poor eyesight or hearing, in others too sharp, some people endowed with very pleasant voice, while other with hoarse or unpleasant, some with strong lungs, others with weak ones, some having a great potential to develop strong muscles, while others to develop the brain and nerves. Similarly, some people learn

foreign languages with ease, others find it easy to learn to dance or mechanical arts, music, horse riding, others languages of geography, history and the like, yet for others it is easy to acquire profound notions and ideas, an in them they find pleasure. In the brain itself, as it appears composed of several mental organs, some predilections may be stronger and some weaker. Hence the various talents and inclinations in people, hence freedom of acquiring some skills and difficulty of accessing other; It is not possible, hoverer, to set limits to which, if continuing from early youth, an organ may not be developed and perfected. It seems that the skilful and well planned education could improve minor defects of elementary education to some extent. Alienated by difficulties, we tend to improve an organ showing greater potential, or ignoring evident potential we do not teach children things which they should be taught but such as common custom mandated and pronounced more in demand. That is why major part of education either misses its purpose or, having no purpose, leads nowhere.

498. — *An image of one's own self.* Since all our representations and imaginations are acquired, so is the image of one's own existence, and acquired very late, too. This is because feeling can not be congenital; otherwise, we would have felt and imagined our *individuality* from the first moment of our conception. But feeling all external things in ourselves, and not in those things, we slowly learn and become convinced that they do not exist in us, nor are we in them, and therefore we are separate and sentient beings.

Similarly, learning slowly that we do not feel ourselves in *individuals* like us, we acquire the notion of the word I.

499. — An image of our own self, therefore, comes very late in us, and probably as late as the memory of our own existence itself. It transpires not immediately after birth, and is a resultant of many feelings, recognitions and previous comparisons. We possess this image when the entire nervous system is active, recognizing sensations and impressions which originate not only in external objects, but also in the changes occurring within us. The fact that feeling occurs in the nerves — in the brain in particular — becomes clear because, *firstly*, only the nerves feel, and therefore whatever feeling and sensation must take place in them; *secondly*, in perfect sleep the feeling ceases; *thirdly*, it ceases following pressure exerted or damage inflicted to the brain.

500. — Feeling of one's own sense of self is usually pleasant, kindling a desire to uphold it, and therefore the desire to maintain behaviour and self-love. This desire for maintaining own behaviour, which is one of the brain functions, is quite different from the power which in organic beings arouses action with the view to good behaviour at a given time, because such moves precede the imagery of one's existence, are unwilling and often unaware, occurring even in beings which do not have brains and thus, are incapable of imagining their own existence.

CHAPTER XXXIV

SLEEP AND STAYING AWAKE.

501. — Every impression of external objects on beings and living organs is a force which must effect in the latter a certain number of changes, reflecting the nature of the external force and the organization. If the entities acting on the organizing bodies are viable, and while acting enter the sphere of activities of the organic force, the result of this mutual action is assimilation, i.e., organic elaboration of the viable entity and corresponding dissipation of the organized entity. Therefore, the losses incurred by this dissipation are immediately rewarded, and the organism not only does not suffer any real harm, but life continues in the ordinary manner. But, if inanimate beings act upon animated bodies, the former will only dissipate and exhaust the more their action is stronger and more prolonged.

502. — The major part of the external bodies acting on the nerves, namely the objects exciting the sense of touch, sight, and hearing, are unable to introduce into them any viable matter which the nerves could convert into their own material. The same thing should be said about the movement of muscles, the action of will and mental agitation. All these activities, inspired by the sensations of objects acting

on the senses and occurring in the neural tissue itself or in the muscles, can not be fuelled by any matter coming directly from outside, therefore they may be called, though not quite properly, *immaterial* activities. The action of will and of some mental powers, initiating the activity of many organs, is connected with the influx of neural tissue, or some part of it, into the muscles and the organs of secretion, thus resulting in its loss.

503. — The nerves and the whole brain mass have, thus, no other source of elaboration and of viable matter except for blood, supplied through the arteries. This supply and elaboration of the neural tissue are at an almost equal level because they are dependent on the rate of circulation and on weaker or stronger elaboration of the arterial blood. Those, in the state of health, are almost always uniform and invariable. True, the elaboration is enhanced by the increased flow of arterial blood during intense brain activity, but if this activity is combined with the equal activity of other organs or the whole machinery, then every rise in the neural tissue elaboration system produces proportional dissipation.

504. — According to the universal law of the organic economy (65–194) every neural tissue elaboration should be suitably balanced by corresponding dissipation. However, if the sensory activity — always *immaterial* — comes into play, as well as the activity of organs elaborated from nerves, then elaboration of the neural tissue must outstrip dissipation, and that, with respect to specific activity. Such a surplus, naturally, will increase and intensify, *firstly*, due to strong

and continuous work of the muscles; *secondly*, owing to the increase in organic elaboration and excretions, therefore, due to every type of work and increased activity; *thirdly*, as a result of continuous and intense activity of the senses; fourthly, by virtue of the increased action of will and, therefore, passions driving strong endeavours and increased activity of the whole body and, *finally*, owing to pain or pleasure. So, if such an imbalance of elaboration and dissipation was to continue, it would finally lead to complete exhaustion, debilitation and incapacitation of the nervous system.[66]

505. — In organic elaboration only that part may be the object of dissipation which has already gone through all degrees of elaboration. Thus, if elaboration were to be maintained at a constant level and uniform in a living organ, dissipation in each case should be corresponding and equal. Otherwise, soon there will not be enough suitable matter for dissipation. And that is the case apparent in the nerves when senses and muscles are continuously active and, therefore, the neural tissue in continuous dissipation. All these activities, being immaterial in the nerves, and in other organs exhausting the nerves as long as they last, as long as nerves have the matter suitable for dissipation, but

66 Assuming the existence of neural fluid, the neural tissue itself could be intact, and only the fluid would be digested; and this is why I have said above that the presumption of such a fluid, though not supported by experience, is far more reasonable than any other reasoning used later to explicate powers of the nervous system.

when that matter, owing to surplus of dissipation becomes exhausted, such activities will weaken and finally will be halted altogether.

506. — But on the other hand, when they are significantly reduced or stopped, the dissipation of the neural tissue will significantly decrease or be halted altogether owing to the scarcity of suitable material, and halting the activities which largely depend on dissipation. Meanwhile, the blood supply continues, and elaboration of the mass will proceed along the ordinary course, thus elevating and surpassing dissipation. After some time the nerves will again be very receptive to outer stimuli coming through senses, and ready to all intangible activities. Because of continuous digestion of the neural tissue, owing to the activity of muscles, organic elaboration and dissipation, as well as the activity of the senses maintaining all intangible activities, the whole nervous system must be at times in the state of domination of dissipation, and at other times in the state of domination of elaboration. The first of those states, maintaining the activity of senses and muscles, is called *wakefulness*, the second is called rest or *sleep*. These two states must alternately follow each other because, due to intangible activities, constituting a major part of animal life, the elaboration of neural tissue can never equal its dissipation. Wakefulness, therefore, depends both on the activity of the senses, both external and internal, and on the so called involuntary movements of muscles. The opposite state, dependent on inactivity of all these parts, is sleep.

507. — So we begin to fall asleep when we become insensitive or indifferent to all the stimuli acting upon our senses, when voluntarily muscles weaken and their movements become unclear and slow. At that time, having removed the objects acting upon senses and laying muscles to rest, the immaterial function of the nervous system ceases and, subsequently, sleep begins. In this gradually increasing indifference of the senses, the eye closes first, while the ear is vigilant the longest; we can hear voices of people talking to us as if from afar. When ears fall asleep, imagination is still watchful for some time, submitting images of things non-existent and incoherent, which we call *dreams* or *fantasies*. As soon as imagination ceases to be active, we lose our sense of self and sleep is complete.

508. — In gradual waking up things go contrariwise, but in the same order; imagination awakens first, including the sense of self, then we indistinctly sense the objects acting upon the senses and, finally, we open our eyes and are completely alert. Dreams are an intermediate state between perfect sleep and alertness; a state in which only the external senses and some mental powers are asleep, while others are still kept active. This half-awakening, or dreaming, takes place only at the beginning or the end of real sleep, and is most often caused by the presence and influence of some external object or a strong impact on any of the senses, namely: external heat or cold, a hard or sharp object, hunger, desire, food in abundance or lying undigested in the stomach, urine, excrement, semen, etc. And if the mind was strongly

moved by some object, this agitation renews and is the object of the dream. So, we are disposed to dreaming and open to dreams when exhaustion of the nervous system due to lack of animation and intangible activities is not complete and, therefore, the inclination to waking up is considerable and the need for sleep is very weak or nonexistent.

509. — The measure of sleep, or its length, depends on age, temperament and the condition of animal economy. During growth, where elaboration of the nervous system should prevail over its dissipation, sleep usually is, and should be longer; the longer the stronger is growth. Carefully watching nature we learn that the unborn child is immersed in an uninterrupted sleep dream until half the pregnancy. Halfway through to the birth, the sleep is interrupted by rare and short awakenings. Shortly after birth, small children are rarely alert. Later, they sleep less and less. Older children sometimes sleep for twelve hours uninterruptedly; young adults around eight, while adults sleep seven or six hours. Tiredness brings about a very clear need for sleep, and sleep itself is stronger and longer. Fatigue and hard work, following continuous and substantial exhaustion of nervous matter, the need for sleep and lack of readiness of the nerves for further activity is so great that there is no stimulus which could keep your senses alert and willing to continue working. For this reason weary soldiers in the battle and under a severe blow of stick may fall asleep; this is why after three days of dancing a four-day sleep is nothing exceptional, and so on.

510. — In true sleep, caused by true exhaustion of cerebral neural tissue, all senses and powers of the mind are perfectly asleep. Likewise, whatever will calm the senses and the powers of the mind and make them inactive must bring sleep, though unnecessary and impermanent. In perfect alertness, all mental powers are active; because anyone who does not sleep, will feel, want, and think. Because every sensation is connected with pleasure or unpleasantness, therefore each keeps it active thanks to the power of will which, in turn, excites other body activities, thus, *firstly*, every rejection and calming of an unpleasant sensation, such as, cold, hunger, thirst, heat, pain, anxiety calms all action of the will, brings about a pleasant quiet, idle pondering, inattention to external impressions and, therefore, sleep. Rocking, which confuses all external sensations appearing in quick succession, removes their influence and puts children to sleep. In a similar way, the murmur of water, humming of a bee, bird tweets owing to many rapid and blurred sensations sent through the ear, confuses and blurs the imagination and thoughts, brings about pleasant contemplation and sleep. *Secondly*: because we wish only for pleasant things, whatever introduces into the nerves a sudden and pleasant feeling, thereby removes all activity of the will, soothes all movements of the body and mind, and induces sleep. Such must be the influence of music, of pleasant warmth, use of tasty foods and beverages, and so on.

511. — Finally, during full activity of the senses, both external and internal, namely, during the work of muscles,

the dissipation of neural tissue prevails. This prevalence will obviously be smaller if the neural elaboration is elevated for whatever reason and continues to be so. This is why long and hard mental work or an intense passion that can neither explode nor can be satisfied, and which increases the influx of blood to the head and elaboration of cerebral mass, deprives us of sleep. On the other hand, because the entire source of neural tissue elaboration is in the bloodstream supplying the brain, then again, any significant loss of blood or its dilution by multiplying other elaborations, and discarding the juices elaborated from blood, must bring about sleep. Hence, people who have been exhausted by bleeding, wounds, vomits, lax, or whose blood is weak, poorly elaborated, can not bear long vigil, nor hard work of the body and mind, but they immediately weaken and fall asleep. Hence the cold, as reducing all the organic processes, and thus elaboration of neural tissue, brings about animal warmth, blood circulation, and deep sleep. Hence, it is easy to see reason in *Mr. Beddoes* observation that reducing the amount of oxygen gas in atmospheric air, or admixing unbreathable gases, soon causes sleep. In this case, the arterial blood elaboration and animal warmth is reduced, and thus are all organic elaborations and dissipation.

512. — Some Physiologists, convinced by experiment that light pressure exerted on the brain causes sleep, understand that sleep never happens otherwise, both in health and in all cases of illness, only by exerting such a pressure. Hence, it seemed to them that the abundant flow of

juices to the head during waking hours was the true cause of sleep. There were others who detected the most probable cause of sleep in falling of cerebral lamina, claiming that in the state of alertness the lamina remain raised. But such a rough and mechanical explanation can not be accepted in the study of animal economy; and it is self-evident that the organ so delicate and soft when pressed is not able to work. This should teach the scholars of nature that much: we sleep when activity of this organ is significantly reduced or partially halted.

513. — *Brown* and his followers attributed sleep to the temporal exhaustion of stimulation owing to constant activity of stimulants in the state of alertness; the latter was attributed to the abundance of stimulation during sleep. As we have shown elsewhere, principles of *Brown's* teaching can not be maintained, and no explanation based on these principles can be accepted. However, it is impossible not to take into consideration that the exhaustion of elements suitable for dissipation in the neural tissue, and their gathering again, in a way reflects the concept of exhaustion and accumulation of stimulation. This was unavoidable because stimulation was accepted as an unknown cause of neural activity. This is because experience shows that this activity at times intensifies, and then it weakens or ceases. The same can be expressed in accordance with earlier learning, owing to the increase or decrease in sensitivity and tenderness; the same is true even from the viewpoint of the general tendency of matter to organize itself, due to viability, or otherwise.

514. — *Firstly*: in the blood there is a general storage of viable matter from which nerves are elaborated. If it becomes exhausted by incessant activity of nerves, loss of blood, substantial bowel movement, insufficiency of aliment or using non-viable aliment; the nerves will not be elaborated enough due to insufficiency of viability of blood, hence, the period of their dissipation will be equally reduced owing to the lack of viability in them. The same is true about reducing the amount of oxygen in the air and disrupted elaboration of arterial blood caused by carbonic acid or hydrogen. *Brown* called this case proper weakness, and was supposed to be dependent on too much stimulation; which, by us, can not be expressed otherwise but as viability and its deficiency in arterial blood. *Secondly*: although as the result of the intense activity of all organs and powers of the whole body, elaboration of the neural tissue proliferates, but its dissipation proliferates far more owing to the increased activity of organs and muscles; wherein there is depletion of viability, both in the nerves and in the blood, but far more intense in the former. This is why adjusting this inequality during sleep, when the blood disposes of viability, and the nerves acquire it, the latter is capable of taking action again; though the blood is less suited for compensating the loss of their viability. Therefore, if one wished to express the cause of sleep and wakefulness in terms of viability, one ought to say that, in wakefulness, viability decreases constantly in the nerves and increases in the blood; while during sleep on the contrary, it decreases continuously in the blood and increases in

the nerves. Which teaches us that unnecessary vigilance, superfluous work of mind and passion exhaust the brain mass and nerves, just like superfluous sleep exhausts the blood.

515. — *Winter sleep of some animals.* Moreover, there are animals which fall into a deep sleep lasting several months. This kind of sleep is called hibernation. It begins in the autumn, when the days are colder, and ends in the spring, when warm days return. Almost all insects and worms, and some warm blood animals hibernate, for example the bear, the badger, and the marmot. This sleep occurs evidently because of external cold; it stops when warm days return. There are other causes, too, especially those delaying or halting elaboration of arterial blood, such as: oxygen deficiency in the air or prolonged insufficiency of aliment which brings about this kind of sleep. This is why insects seal off before they fall asleep, and it may happen even in mid-summer during their metamorphosis, thus preventing access of oxygen. Similarly, some others seal off in the autumn when they prepare to the winter hibernation.

516. — The cold does influence these animals by slowing down all organic processes and thus decreasing animal blood elaboration, and inhibiting elaboration and dissipation of neural tissue. Therefore not only a deep sleep begins, but also deceleration of all organic activity to a degree which allows life to continue. If it becomes extremely cold, the sleep may end in real death. All other animals, with man being no exception, do fall asleep in the same way as the result of the cold, but this sleep ends with very quick death.

The entire reason for this difference lies in the more complex and perfect organization of these animals which can not stand such powerful deceleration of organic processes without loss of life. The more complex life is, and the more perfect, the easier it is to extinguish.

517. — Observations and experiments performed by *Spallanzani*, *Senebier*, *Mangili*, *Prunelle*, and others about hibernation in animals taught us that, *firstly*: the cold is the most important but not the only condition for winter sleep; it is the calmness, insufficiency of aliment and, and above all, decrease of oxygen content in the air also helps. Using artificial cold, these animals can be put to sleep among the greatest heat, just as artificial heat can be used to wake them up among the most severe frost; *Secondly*: the cold making hibernation possible should be slightly stronger than zero degrees *Reaumur*; if it is too sudden, the animals already asleep wake up, and then fall asleep and die again; *Thirdly*: the animals which are asleep breathe slowly, their blood flow is slow, and they use very little oxygen; *Fourthly*: their animal warmth decreases to one or two degrees above zero; *Fifthly*: when they wake up, they return to the ordinary inner heat even though the outside temperature was the lowest. *Finally*, some of these animals wake up several times and eat at that time.

Chapter XXXV

SHORT CONSIDERATION OF THE RELATIONSHIP BETWEEN DIFFERENT ORGANS CONSTITUTING MAN.

518. — We have analysed as briefly as possible the activity and manner of manifestation of life of each and every organ. We should now consider these organs as interconnected and consisting of a single organic entirety; observe how they affect one another's life and activity in a variety of applications. We have become more or less familiar with some of these relationships, what remains to be done now is to bring them all closely together and make connections so that they could form, so to speak, a decent unity.

519. — Every organ and every living part is perpetually elaborated and dissipated, since life depends on it in general (65). This elaboration and dissipation is not in the realm of senses and may not be subject to experience as to how it occurs, and therefore, the very essence of life in general, both organic creation as in *individuals* and organs must remain beyond our comprehension. But the organic elaboration and dissipation of matter, occurring by the power of certain forces, is linked to certain stable phenomena on the

basis of which we conclude about life and its various states. These phenomena, which we have called manifestations of life are: receiving a certain kind of foreign matter; its continual transformation; excretion of the transformed matter; in early life, growth and continuous propagation and improvement of the organism, then maintenance in its entirety, elaboration and preservation of the proper body temperature, motion, and in the more perfect beings feeling, thought and will. The first phenomena occur in the whole animated world, in all living entities and organs; movement is distinct only in the muscles and, therefore, in the entities endowed with muscles, while feeling and the mental faculties only in the neural tissue. The maintenance and development of the latter depends on existence, entirety and life of the latter because both nerves and muscles are elaborated only from viable matter which has been largely transformed, well advanced in organic elaboration, possessing strong animal characteristics. In *individuals*, the acquisition of animal characteristics is tied most strongly to breathing, thanks to which blood constantly absorbs nitrogen, losing much of the carbon and some hydrogen, and then serving a similar animalisation of other organs it circulates through, it supplies them also more or less with nitrogen. So, elaboration of nerves and the brain in *individuals*, and therefore, sensations and sustenance of mental powers, depends on existence, perfect elaboration and constant circulation of blood. The existence, constant circulation of blood depends, in animal organism, on: 1) on the entirety of vessels and the heart,

2) on the entirety of lungs, 3) on the entirety of and excellent performance of lymphatic vessels. As far as viable matter is concerned: 1) on free access to, and characteristics of the air, 2) on the use of decent aliment and drink.

520. — Lymphatic vessels would have supplied little or no viable matter to the blood, or would have supplied low viability matter or, finally, non-viable matter altogether if the lymph was not refreshed with chyle, whose existence and elaboration is indispensable for elaboration and good condition of blood, and thus, the organs dependent on its existence and condition. So, organs elaborating chyle are equally necessary for sustenance of the whole animal economy. These organs, as we saw above, are numerous: the mouth, teeth, salivary glands, throat, stomach, bowels, liver, spleen, *pancreas*; they all contribute to the elaboration of chyle, thus influencing the entirety and proper existence of the whole organism, though from a distance and less directly. Therefore, life and the entirety of muscles depends on the condition and elaboration of blood and nerves, while the nerves depend on the blood; the blood directly on the lymphatic vessels and lungs; while indirectly on the entirety and activity of digestive organs. The activity of digestive organs depends on viable matter arriving from the outside, and on its nature. The viable matter, which is the basis of elaboration for animals is in the plants, air and water, so the existence of all animals and animal organs in general is attached to the existence of plants, water and air.

521. — The willful movements in man therefore depend on the entirety and activity of the muscular and nervous systems; the activity of the latter, and therefore of the mind and the will, depends on the state of circulation and blood itself; circulation and state of blood depends on breathing and elaboration of chyle and lymph; the elaboration of the latter depends on the condition of lymphatic vessels, while the elaboration of chyle on the condition of the digestive organs and fluids. Digestion is the first introduction, and the most distant, but inevitable precondition of all human activities. Another distant but important condition is the function of the lymphatic system. Without these, the elaboration of blood slows down and finally ceases; and this weakening causes the cessation of functions of the nervous and muscular systems.

522. — Halted or damaged process of digestion and insufficient aliment, as well as lymphatic depletion, lead either to complete deprivation of blood from viable matter, though slowly, when we halt the breathing, immediately restraining the elaboration of arterial blood and its supply to all organs, the activity of the nerves, muscles, and the organs of secretion at this moment holds and ceases. This observation should be supplemented by the remark that it must be in breathing and arterial blood elaboration that the whole source of animal heat is to be found, without which no organic process can be sustained. It teaches us that breathing and continuous connection with the air is the precondition

of life and the lungs are one of the most important organs. We can only breathe atmospheric air, not otherwise, and the state of our life is directly connected with the state of the air. From a different viewpoint, blood circulation organs are necessary to sustain life, and they are not less important: the heart, the aortic and pulmonary arteries trunks, specific arteries supplying blood to specific organs. Without these organs the heating process and all other animal activities would immediately cease. This is why these organs and lungs were formerly called the innards of life, for their destruction or halting their activities stops the entire course of life, or it ends immediately.

523. — We live an accomplished life; *firstly*, as long as digestive, lymph elaboration, and blood circulation organs are intact and work closely together, as long as nerves and muscles function; *secondly*, as long as we are immersed in the air; *thirdly*, as long as we have water and plants or animals already elaborated from them. Obviously, not only is it necessary to maintain the relationship between all the organs that constitute us, but also the permanence of relationship with the rest of the organic creation, and with the air and water. What makes us understand again is that we are only a small link of the huge organic chain, and this chain is, in turn, only a small cog in the general physical design of the globe; which itself again may be a small particle in the vastness of the world. Moreover, it makes us realize that the whole physical world is an unbroken chain of beings and phenomena so closely interconnected that any

interruption poses a risk to the whole construction. Finally, we return to the assumption established at the beginning that the entirety of organic beings is a single animated whole of which parts are so intertwined, and so interrelated as organs of the same *individual*. The latter are essentially bound because one elaborates and prepares viable matter for the other, similarly, plants adopt matter for animals, playing the same role in the whole animated world, which is played by digestive organs in *individual* animals. Reciprocally the animals, bringing the elaboration of matter to the highest degree, and thus giving it the greatest propensity to dissipate and to pass to chemical combinations, prepare it again for the plants. What a perfect, splendid unity! What inconceivable greatness of the Creator who designed it! What strange quality of human mind which encompasses it!

524. — However, there are organs in the animal economy which may be or not be working, and this does not cause immediate death or significant depletion. These are, for example, bones, whose objective seems to be to give the entire body a certain unchanging form and a permanent attachment and support to the soft parts; Such is the cell membrane, essentially designed to bond together parts and organs and to store and perhaps process moisture which lymphatic vessels absorb and elaborate the large part of lymph from. Such are all smaller vessels, and muscles, and nerves entering them. This is why complete and even substantial parts of organs consisting only from muscles, vessels and nerves can be lost by the organism without loss of life. The obvious

and very common example of this is in healthy and stout people whose legs, thighs or shoulders have been removed. Similarly, sometimes significant damage or deterioration of the cerebral tissue has been seen which, either by overstraining certain powers of the mind or not changing it in any way, did not badly interfere with the life of other organic parts. True, there were cases of foetuses completely perfected and grown, which were born without the head or without the brain, and which grew and took form in the maternal womb without that organ. Examples of nerve-free creatures can be found in many worms and insects; examples of life without the brain and nerves can be found in plants.

525. — In man, however, and in more perfect animals in whom the neural tissue embraces all the organs of motion and secretion, and in whom it is part of nearly all organic elaborations, withheld neural activity weakens, halts or cancels movement; mixes, changes or obstructs organic elaborations; withheld activity of the brain does not provide matter needed for the renewal of the nerves. Therefore, in more perfect animals, life is easier to cripple because it depends on a larger number of conditions; in other organic beings, the simpler it is, the sturdier.

526. — Similarly, to be precise, what is not part of *individual* life is generic organs, both male and female, and they can be destroyed or amputated with no loss of life, as chapter eight of this lecture teaches us, as evident everyday experience of observing plants, animals, and ourselves. Female and male generic parts taken together constitute only one

organ; but in the more perfect beings it is separated in two, and located in two separate *individuals*. These are two parts of the same organ, though belonging to *individuals* to whom they have been given, and are elaborated from their own blood and nerves, and they give them drive to join those two organs in one; only then, having been joined together, this organ performs its function completely. Therefore, following a destruction of this organ in the individuals, only such drive is abolished, though *individual* life suffers little as a result.

527. — But on the other hand, all organs elaborating organic combinations intended as excretions, such as kidneys, large intestine and the skin, are inevitable for continuation of life because, at any time, the organic elaboration should correspond to dissipation, and excretions should correspond to the influx of viable matter. Nonetheless, it is also true about the elements which are to be converted into excretion combinations, being non-nutrient for the rest of the living body and, as non-viable, obviously harmful. Otherwise, it would sooner or later end with dissipation and disaster for the whole *individual*. For the same reason, the entirety and activity of lymphatic vessels is important, which absorb the dissipated organic matter from all organs and transport into the blood, and therefore, are an essential condition for organic dissipation and, consequently, excretions.

528. — Nevertheless, even organs less necessary for life, belonging to the entirety of the living *individual*, have their intent and certain functions, to some extent influencing

other organs; their destruction obviously brings about change throughout the system, though less rapid and less violent. An obvious example is *castration*, following which the flesh weakens, courage withers, the beard stops growing, there is a strange sluggishness of movement and a tendency to obesity.

CHAPTER XXXVI

DIFFERENCES BETWEEN PEOPLE RELATED TO CLIMATE.

529. — We have already said that man is only a small part of the entire organic world and the world, in turn, is small part of the physical world (523). So whatever the relationship and mutual influence of the various organs constituting man, there is a similar, and equally inevitable relationship of man with the rest of the animate creation and with the physical world, a powerful and obvious one, certainly exerting influence on his condition and existence, be it the surrounding organic beings, the air, the earth, the water, ambient temperature or its variations which can affect changes in the air, the water or the earth.

530. — In common view, climate is meant to signify the latitude of a place or its position relative to the sun, indicating its average temperature dependent on different length of day and night. Disregarding the fact that ambient temperature is influenced not only by the latitude of place, but also its elevation or depression, the nature of the earth, the proximity or distance of the mountains and the sea, the abundance of water or dryness, wealth and location of forests, and so

on; the notion would not cover, in this sense, the whole effect of a place on earth the man inhabits on his organism. Thus, the notion of climate, more so in the physiological and medical terms, should be understood not only as latitude, but rather the whole physical constitution of a place. In this sense, speaking of climate, it is not only the latitude and the average temperature of the place that matters, but the nature of the land, of winds, population, the abundance or lack of forests and, first of all, the nature of aliment, thus the plants and animals inhabiting the place.

531. — The average mean indication of the barometer should be the most important for defining climate, because high altitude countries, though their geographical latitude is low, are located in the position advanced towards the poles, and temperatures close to polar, with similar plants and animals. Winds usually influence the temperature and the dryness of the atmosphere, and causing abundance or lack of rain, also greatly affect the nature of the climate. Although man inhabits all latitudes, stretching from 80 ° north to 58 ° south, one could not say that he is fit to live everywhere. In countries where the cold is severe, man survives only owing to artificial means, and spends most of his life indoors, setting up artificial temperature for himself. During the long winter, he digs in, sleeps long and is often ill, moreover, people living in these countries are small, weak and dull, as example shows in the inhabitants of Lapland and Greenland. Hence, the thought of *Linnaeus*, who thinks that beautiful Asian climates were the home of the first people on Earth

may not be far from the truth. Nonetheless, in that extent one should consider the different types of man, of whom each one seems to be created for another part of the Earth.

532. — Thus, the climate, defining ambient temperature, the length and severity of winter, the nature of food and drink, must necessarily influence the physical constitution, character, genius, and customs of the nations. And this is one of the reasons why we see such great differences among the peoples inhabiting various parts of the globe. Without going into finer details, generally speaking, the inhabitants of hot countries avoid work and energetic movements of the body, which exhaust them and make them sweat excessively and unnecessarily. The lands they populate are wealthy and fertile, therefore, for them, hard work becomes unnecessary. Owing to hot temperatures in which they constantly dwell, due to spicy, hot foods they use, their rate of life is constantly accelerated and, therefore, they mature faster, are born, age, and die earlier. Inactivity makes them effeminate, soft, weak, giving a significant advantage to the nervous system which, owing to accelerated course of life and the said inactivity, elaborates strongly and does not dissipate at the same ratio and, for that reason, and they are all too sensitive, temperamental, easy to fall in love and be torn by jealousy. They compensate insufficient dissipation of the nervous system resultant from lack of hard work and body movement with activity and powerful agitation of the mind. Hence their imagination always active and burning, hence the strongest passions of pride, disdain and ambition, hence

all manner of exultation, enthusiasm and fanaticism. This is why the inhabitants of hot countries were the first creators of poetry and religious sects, hence the countless number of martyrs in every sect, hence exulted, pompous and exaggerated speech, so distasteful for peace loving and reasonable nations.

533. — On the contrary, the inhabitants of cold countries must compensate considerable losses of animal heat by its prompt and powerful elaboration through strong elaboration of arterial blood and accelerated circulation; therefore they are forced to be in constant movement and engage in work. In addition, the climate in which they live is less fertile, the summers are short; in this short time they have to make provisions for food, shelter, protection for long and harsh winter and, therefore, must be in uninterrupted movement and work, thus they constantly strengthen and perfect their muscles, as they excel in physical strength. Hence, the northern nations, but not inhabiting the far north,[67] are hard-working and courageous; for courage is born from the feeling of one's own strength. That is why these nations have always been invasive and warring; history shows us hordes flooding and conquering peoples settled in better lands.

67 I say not inhabiting the far north, because those living in the far north, and who bury themselves beneath the ground for entire winter months, sleeping and slackening in misery, weaken their muscles because of such severe winter rather than strengthen them during extremely short summer.

534. — In cold countries where, provided the same lung volume, we breathe in more air, elaboration of arterial blood is much stronger. Indeed, in order to maintain balance with the outside temperature it must be stronger; disposing of carbon dioxide must be more generous, on the other hand, ingesting nitrogen, therefore animalisation, must be more significant. In addition, animal elaboration may be stronger also because these hunting and fishing nations feed largely on animals and fish, and some do not even know bread. Hence strong inner warmth, hence ruddiness and freshness of these peoples, but by the same token, the activity of lungs and arteries is far greater, and thus, faster maturation and elaboration of those systems and stronger tendency to haemorrhages and pulmonary diseases. In hot countries, animalisation and elaboration of fibre is much poorer, dispersion of carbon dioxide is worse, this is why these nations are lazy, dark, gloomy, brown or olive skinned; hence, weaker lung activity and extended life of the lungs, and the prevalence of biliary system and special disposition to related diseases. The superiority of the muscle system does not allow nervous system to abound; therefore, in the northern nations there are fewer poets, and in their poems there is more decisiveness and power and less imagination and zeal. Hence, the northern nations, providing the strongest soldiers never gave us religious sects or martyrs; hence their wars were almost always over bread and houses, and never over faith.

535. — The happiest are the nations living in temperate climates; their nervous, arterial, bile and lymphatic systems

are in decent balance; physical strength not too abundant, power of mind quite strong. Such nations give excellent knights and sages accomplished in every sense of the word; they have religion without fanaticism, courage without cruelty, gentle customs, and moderate government; while a southerner is necessarily either the most powerful tyrant or the meanest slave; while a northerner despises government and yearns only to wars, licentiousness and indulgence. It is to the climate that the major part of Europe owes its superiority and dominion over the rest of the world.

536. — In order to learn the constitution and character of the peoples dependent on the land they live on, we must reach into the history of the ancient peoples. In contemporary times, when widespread trade has connected nations of the whole globe, where the refined sciences and crafts give people a thousand ways to improve their own existence and to affirm all kinds of comforts, where the northerner lives calmly in temperature proper to moderate climates and feeds on an abundance of food harvested in hot countries, where he thrives in idleness and enjoys the most sophisticated comforts of an Indian; his skin is equally soft and damp, his muscles as slack and weak, his nerves are equally straggling and sensitive as nerves of the other one. In short, this lecture could seem to be imaginary and far from the truth to all those who see only the educated and wealthy people. But let us look at a simple man living from manual labour, not debased nor transformed by slavery, and let us compare

such an inhabitant of cold countries with his counterpart inhabiting hot climates.[68]

537. — But even European peoples differ in qualities and inclinations, in ways of thinking and behaviour. These variants depend, of course, on the countries in which they live, on foods and beverages they use, on customs and rituals, both religious and governmental and, finally, on their political and trade relations with other peoples. Whoever would want, remembering the foundations of our lecture presented at its beginning, to examine and determine the constitution and nature of various peoples, could easily point to the sources of their tendencies to behaviour and thinking, as well as their inclinations to certain kinds of illness. But such minor details may not be the intention of this treaty.

68 The constitution of the northern countries and the character of the peoples inhabiting these countries, as I see it, shows best in the Tatars, and particularly in the Mongols. Their country, elevated far above sea level, is stably cold. This is why these hunting and warring peoples have more than once flooded and conquered Asia and much of Europe. That is why what we have said about the qualities of the inhabitants of northern parts is best featured in them.

CHAPTER XXXVII

DIFFERENCES IN ORIGINAL FORMATION OR TYPES OF PEOPLE.

538. — Indeed, climate influences the constitution, character, genius, and customs of nations. It can even foster certain kind of diseases and bring them on, as we have an obvious example in the *Cretins* who inhabit only in the *Helvetian*, *Piedmont* and *Salzburg* valleys, but climate can not form a man differently, namely transform one kind of people into another as some writers think that climate on its own can remodel a European to be a Negro and to the reverse.[69]

539. — Watching closer the diverse peoples inhabiting the globe, we can see obvious and inevitable differences not only in the way of life, customs and nature, but also in their organisms, both external and internal. A Negro, for example, not only differs from a European in the colour of the skin, but also by the whole organic layout. The design of his head and face is completely different; the jaw is prolonged, the forehead squashed, the volume of the skull and brain

69 Camper kleinere Schriften. [Petrus Camper, *Sämmtliche Kleinere Schriften die Arzney-Wundarzneykunst und Naturgeschichte betreffend*. Ins Deutsche übers. v. J. F. M. Herbell, Leipzig: Crusius 1787–1788].

is far smaller, the lips thick and curving outward, the skin black, oily and woolly. Nor may you understand that such variations of colour and shape depend on the climate in which he lives. Negroes who have moved to Europe, as well as Europeans to Africa, retain their colour and all their elemental composition, nor their children are born different than their parents; if parents mix, they have intermediate colour and shape, in the same way, and according to the same laws we see in progenies emerging from merger of plants or animals of the same species and different genera.

540. — The most obvious differences in colour and composition of the body can be observed, apart from the Negroes, also in members of other tribes, regardless of the climate in which they live. And so, the red Peruvian lives among the white and the black; the white Abyssinians live in the same climate as the Negroes and the Dutch who are settled for two centuries in the Cape of Good Hope, have not turned into Hottentots. A glance suffices to see distinct differences in some species of the humankind, which are not, and can not be in any case a work of art, being in this or that tribe common and hereditary. And so, what of the work of art is there in protruding cheeks, crushed foreheads and Kalmyk tiny eyes? The Caribbean squashed skull and nose? Slanted eyes of the Japanese and the Chinese? Spiky head of the Siamese? Light or even yellow hair and blue eyes of Europeans are characteristic only for them and can not be seen elsewhere.

541. — For such reasons natural historians have been long compelled to accept the existence of a few primordial

varieties or tribes of humanity, though some of them admit smaller numbers than others. Nor it is easy, in the great confusion of these tribes, to delve into the root of their differences. Thus, following only the external characteristics, clear and unchanging, it appears to be possible to assume five elementary species or generations, namely: *Celtic*, *Mongolian*, *Malay*, *Negroid*, and *Caribbean*. The first, whom some authors divide into two branches, is white; often has light hair and great power in the muscles. This tribe, which is by nature warlike and sturdy, has subdued almost all European nations, as well as real Turks, Persians, Arabs and Moors. It is generally understood that this warring tribe was originally groomed in the Caucasus and on the shores of the Caspian Sea; it conquered and settled all over Europe, and this is why, though merged with other tribes, peculiarly with Mongolians, has still preserved many Asian customs.

542. — All body members of the Mongolian tribe are dry and brown even in cold countries. Some divide the original tribe into three generations, of which two live a life of nomads and occupy almost all areas around the North pole around Spitsbergen and Pechora, as well as Greenland, Kamchatka, Samoyed, Lapland and Finland. Some authors count true Hungarians to be part of this tribe, though it has very little likeness to the truth. All these northern peoples, living mostly underground or in huts, are dry, brown, short, with small heads, lean, and deprived of courage. The second Mongolian tribe, generally very ugly, embraces occupies the Aleutes, the Kalmyks, the Tungus, the Bashkirs, the Kirgiz,

the true Cossacks, the northern Chinese, and some Tibetan tribes. The tribe, living almost always on horseback, engages mostly in robbery and pillage. The tribes of southern Mongolia, situated behind the Ganges, are the third branch, which is incomparably more polished and mild. They are: the Japanese, peoples of Yesso, Tibet, Siam, etc.

543. — The Malay tribe has a great similarity to the preceding peoples, and extends from the peninsula of Malaga to the islands of Sumatra, Borneo, Ceylon, Philippine Islands, Molucca Islands, parts of Madagascar, and parts of New Guinea.

544. — The Negro generation, or the Ethiopians, are also divided into two tribes, the first of which occupies all Africa around the equator, Nigeria, Guinea Kaffraria, Congo, Angola, the shore of Zanguebar, the central part of Madagascar, and Papua or New Guinea. The second generation of Negroes is rather dark-olive but very close to black colour, and embraces the Hottentots, tribes of New Holland, Quiros and New Caledonia. The Caribbean tribe, or the original American race, is reddish and occupies all of South America.

545. — Though the above basic divisions have been generally accepted, the differences between original tribes in the already intermingled peoples are often unclear, so that there may be nations whose externalities are indistinct owing to blending of two or three generations. An example can be found in some very familiar northern peoples, who are a distinct mixture of the Celtic and Mongolian tribes, as can be evidently seen in some Tartars and Cossacks; similarly, there

are some southern peoples originating from the blending of the Celtic and Malay tribes. So it is no wonder that various authors disagree as to the establishment of such elemental tribes, and we have followed the trail close to the truth.

CHAPTER XXXVIII

DIFFERENCES BETWEEN PEOPLE REGARDING THEIR TEMPERAMENT.

546. — But in the same tribe, the same nation and climate people are not quite similar. Indeed, they differ in height, facial structure, colour of the hair and eyes; we can see that they differ greatly in character and inclinations, in their ability to think and act, and a stronger tendency to these or other diseases. Such smaller differences between people where known by the name of temperament; though more properly should be called *individual constitution*. These constitutions or temperaments were attempted to be depicted by certain divisions, established in the oldest medical schools and, to a large extent, based on false theories later on, adhered to presumptuously and respectfully. *Galen*, according to four accurate properties of organisms adopted in the schools in his times, established four types of temperament: dry, moist, cold and hot. Others, having regard for the four *humours* or *fluids* in the human body, divided the temperament into sanguine, watery or phlegmatic, yellow bile, and melancholic.

547. — This ancient science, though based on weak foundations, has survived until our times and has filtered through even to commoners and colloquial speech. And although more recent authors felt very well the weakness of the principle on which it was supported, they retained the science itself due to the respect for antiquity, they trying only to base it on assumptions closer to the truth and consistent with the advancement of the art of medicine. *Haller*, having accepted the notion of four temperaments, did not base them only on the properties of blood, but also on the constitution of parts of the body. In his view, the melancholic temperament depended on lesser sensitivity associated with weakness and tenderness of the fibres, the phlegmatic on low sensitivity associated with weakness and abundance of water, the choleric temperament on volatile alkaline sharpness associated with more tenderness, sensitivity and fibre strength, and sanguine temperament on abundance of the red fraction of blood, lesser tenderness and moderate strength of fibre.

548. — Of course, this is preserved by the respect and dissemination of ancient beliefs and justified by the drawing of *Haller's* earlier views on the animal husbandry. But analysing the issue in greater detail it seems that the old scholars used the expression of temperament without attaching to it a specific meaning, and the science about them and the resulting divisions were based on inaccurate or erroneous imagery; Therefore, this science is not worth the respect so far shown in medical schools. If temperament or *individual*

constitution is to express all the differences presenting in the same generation of people in their tendencies and dispositions to certain classes of illness, these minor differences are, so to speak, unlimited; because there is no *individual* that would be similar to another. Yes, the same *individual* is different as to age, way of life, education, and the temporal influence of the objects around him. Neither can these differences reasonably be drawn from the various amounts of juices, because one would be obliged to prove first that, apart from the difference in these juices, no other difference occurs in the composition of *individuals* differing in constitution; not only can it not be proven, but it violates all observations. As we perceive the most obvious differences between the composition of the face and the whole body, we also see the differences attached to those constitutions, tendencies and talents which we can frequently judge without error at the first glance; and what should have long ago convinced us that the notion of *individual constitution* encompasses all visible and invisible differences in the organization. So, the query ends with whether or not such differences can be attributed to certain subdivisions. And if so, which ones?

549. — Variations of as intricate an organism as the human can be infinite and impossible to depict. And that, in fact, they are so; we are convinced by daily experience, because we never see two faces quite the same. However, these infinite differences are not an obstacle to making certain divisions, indeed, to facilitate the understanding of things they are indispensable. And so in common speech, we divide all

faces into dark and light although these two divisions by no means cover all the differences. By the same token we ought to grasp some of the more important and broader differences between organisms on which the study of *individual constitution* can be based. But these differences of constitution, too, are so numerous and detailed that they seem to require much division. Therefore our remarks in this regard, as yet imperfect, we shall limit to more general ones.

550. — *Firstly*, all the differences in constitution could be boiled down to two original categories, namely, to the elemental and steadily maintained difference in organisms, and to the rate and power of the course of life. As to the first; notwithstanding all minor variations, character and inclinations depending on those variations, the prevalence of one of the systems constituting man, and thus, exaggeration of life of this system, gives rise to a certain kind of revelation which signifies elevation of that part of the organism and, to a certain extent, is shared by all *individuals* falling into similar category. For example, exaggeration of the nervous system or musculature, which could be called *nervous* and *arterial constitution*. We often inherit these constitutions from our parents; it is evident that some are born with far larger brain and more abundant nerves than others, and that they have by nature more sensitivity and better mental capabilities. But such an inborn constitution can be greatly improved by the upbringing and way of life which will maintain it within decent limits thanks to incessant work, hardships, and building powerful muscles; and,

to the contrary, softness or lewd life; total commitment to mental work and strong passions with simultaneous neglect of work and body exercises may grant nervous constitution even to those, whom nature has refused it.

551. — The nervous constitution is not only characteristic of certain *individuals*, but of entire generations, families, and nations. All refined peoples, devoted to science and crafts, all rich nations engaged in trade, and therefore soft, all *individuals* leading sedentary life, namely, men of letters, woman, a major part of artists and craftsmen, all rich people, have this kind of constitution, acquired, if not natural. Throughout their whole life cycle they cultivate and perfect it, and bestow it upon their successors. Persons with this constitution have delicate and soft skin, weak and tender flesh, they fear slightest pain, shudder at every knock or scream, like long sleep; according to character or type of upbringing, they either love music or poetry, the theatre, romantic novels or, given to devotion, tenderly wonder upon the pleasures of future life. They like company and urban life; every joke, every anecdote, every witty comment excites them and makes them happy, they are always inclined to moderate laughter or premature sadness. In today's state of refinement and softness, this constitution is the most common in Europe.

552. — The distinctive features of athletic constitution are: the power of muscles and their perfect expression, low sensitivity, mediocrity of mind and great physical strength. The people with this constitution are often dry, but strong,

and have very well-articulated muscles. They like work, hunting, war, and rural life; poetry and eloquence has little effect on them, science and work of the mind are the objects of contempt. Wit either does not amuse or offends such people and all their delight and glory lies in affliction and destruction either of those bearing their likeness or, if such are lacking, in affliction and destruction of animals. This constitution is proper for the northern peoples and nomads, it is common in the countryside and among agricultural or warring peoples; rare in the cities and nations of scholars or tradesmen, more frequent among men, and quite rare among women.

553. — These two constitutions can not be mixed, one or the other must prevail, and to a very different degree. Which also makes a significant difference between *individuals*. The midpoint between them is the happiest gift of nature.

554. — Moreover, there are people in whom blood vessels are more abundant than other parts, their arteries are large and strong beating, veins articulated and always tense, cheeks strongly reddened, and animal warmth considerable. Such people do not like heat, and they blush and become feverish when it is slightly hot; they are prone to haemorrhages and inflammations of all kinds; with the slightest movement they sweat and warm up unnecessarily. This constitution could be without error called sanguine. But such a constitution, which gives predilection to certain kind of illnesses, has little effect on character and inclinations, and may be equally linked to nervous or athletic constitution, or

may not be connected to any. In the first case, it is accompanied by active mind, strong and sharp wit, in the second, only increasing and accelerating the activity of muscles, it gives a greater impulse to all the tendencies of the strong constitution, and thus gives rise to immoderate activity, of pain and severity, and disposes for the most violent emotions and hot-headedness.

555. — But if sanguine constitution is neither accompanied by significant abundance of muscles nor intensive activity of the nervous system, then blood gathering, especially while living in welfare accompanied by soundness of digestive organs, can be very strong. In this case, elaboration of any juice originating in blood may be abundant, if other local conditions are conducive to this elaboration and maintain it. And in this case, strong elaboration of semen is established in people given to lust, bile in the hot climates or in those abusing strong beverages, obesity in those infirm and inactive. Hence lust and obesity are in every case the result of sanguine constitution and inactivity.

556. — And, just as in some people blood vessels may be in abundance, it seems that lymphatic vessels may also dominate in others; their number may either be balanced with blood vessels, prevail or be less. This power and plethora of lymphatic system can not have any effect other than powerful absorption at all points, profuse lymphatic production, and abundant supply of lymph to the blood. So, this type of person should be dry and sanguine, their organic elaboration and excretions should be strong and, for them, the

outside heat should not be very annoying. On the contrary, those in whom the lymphatic system is less active must be obese or swollen, their blood less plentiful and watery. Such two modifications of the organic structure may also be associated with athletic or nervous constitution.

557. — The food, typical for some people, or even nations, seems to depend only on the accelerated course of life, and can accompany any constitution; though it is true seldom about athletic, and most often about nervous or sanguine constitution. Food is, of course, constitutional because we consume it from the very birth and continue until death. What we eat is expressed in all our activities and movements, finally, in people who are of slow nature, it excites and maintains everything that accelerates the course of life, namely: passions, wine, fever, etc., it is therefore appropriate to accept the fact that there are people whose course of life is constitutionally accelerated, and there are such in whom it is delayed. This difference may only depend on the original drive, or the power of the first movement of life given to us by our parents or, what amounts to the same thing, on the elemental force of the organizing power; because experience shows that the agile are born by the agile, the slow by the slow, the strong or infirm by the strong or infirm. In people with this constitution every organic process is fast, their passions are violent but short, their undertakings begin instantaneously, and change instantaneously, their illnesses are violent but transient. They grow and mature faster than others, they

grasp ideas with great ease but forget quickly. They exult over every novelty, but soon stop thinking about it.

558. — On the contrary, people in whom the course of life is delayed have slow pulse, pale faces, blurred eyes and weak gaze, lazy movements of the body and mind. External stimuli and changes are slow to excite them, but stimulation is more permanent and more difficult to erase. They are slow to understand, but once they have, they will remember what they have understood perfectly and for a long time; such peoples friendship is lifelong; hatred or desire for revenge eternal; they never forget or forgive a grudge. Their health seems to be solid and sound, but the diseases more serious and permanent.

CHAPTER XXXIX

DIFFERENCES BETWEEN PEOPLE RELATED TO AGE.

559. — Never a man differs so much from himself as at various stages of his age. The differences which result from the dissimilarities in the original generation, climate, temperament and even gender seem to be far smaller, or less likely to be visible. An adult is nothing like he has been when he was an infant; nor a senile old man when he was a youngster. A disparate form and composition of the body, other wishes, inclinations, needs, another way of thinking and conduct. The entire human life is a course of constant changes and transformations about which we have been wondering, perhaps comparing it to metamorphoses in insects; though not so apparent, nevertheless important and certain.

560. — Though the entire human life is a course of constant changes and transformations, there are several important ones which we should take as milestones, and on them establish divisions in this unbroken course. In my opinion, these various epochs of human life could be brought to the following: 1) From conception to birth or emergence in the world. This epoch should be called foetal life. 2) Infancy. It

lasts from birth until the formation of the primary teeth. 3) Childhood. From the formation of the first teeth to the dentition of permanent teeth. 4) Youth. From the end of childhood to the complete development of sexual organs. 5) Maturing. From the end of the previous epoch until the meridian of life. 6) Continuation. From the meridian of life until the 50 or 60 years old, or rather until the disappearance of monthly excretions in women ends and the genital loss in both sexes. 7) Old age. From the end of the preceding epoch usually until death, sometimes until senility associated with the loss of many or all of the mental and muscular powers.

LIFE OF THE FOETUS.

561. — The beginning of *individual* life takes place in an egg which, together with the male semen, is given a total *individual* strength (139). The eggs in our genus are distinct tiny follicles, elaborated and matured in the ovaries. When they have matured, and have been fertilized, the follicles peel off and wander to the cavity of the uterus. Placing the total *individual* strength in one droplet of liquid is concentrating in it the greatest strength (156) on which the beginning of the new being is dependent.

562. — The fertilized egg, moved to the cavity of the uterus, finds all the conditions needed to begin *individual* life and, most importantly, decent temperature and decent aliment. Firstly, therefore, *individual* force is exerted on the egg and on matter contained in the egg, and with this life begins, but soon, having cut across the whole droplet of

fluid, and having established the course of a new life, the force needs continual accession of fresh matter on which it could exert itself. This matter is perpetually supplied by the mother. From the moment of conception, the uterus begins to experience constant changes, always satisfying the needs of the new foetus.

563. — These changes depend on the continuous swelling of the uterus, widening and extension of blood vessels and the corresponding, far more abundant influx of juices. The inner surface of the uterus begins to ooze with the gluey moisture which is soon organized, and gives rise to the spongy membrane called *decidual membrane* (*membrana decidua*). This membrane, larger than the egg, is very well visible, inlaying not only the entire internal surface of the uterus, but turning towards the egg itself and forming its outer shell. In short, the uterus which, until the time of implantation of the egg, was an inactive organ now becomes one in which new elaborations take place and new organic forms are created.

564. — As soon as the egg moves to the uterus, it affixes to any part of the uterus and, at first, takes the shape of barely attached follicle, then begins to grow noticeably, and at nine weeks after conception it begins to reach the size of a chicken egg. At the beginning of pregnancy, the organization of the egg itself is not visible; but as it grows, when the outer shells are slightly more stretched, it is noticeable that they encapsulate a fluid in which the forming foetus begins to float. At that time it is possible to observe an organic

part on the membranes, interwoven from numerous vessels, which we call the *place* (*placenta*). This organ ends with an umbilical cord on which the foetus is suspended.

565. — As soon as the foetus itself can be seen, one notices among the sticky mass a vibrating point which is the heart; apparently the first working organ and the first one catching the eye. Precise perception in this respect is very difficult and barely possible. When the beating organ appears, the larger vessels begin to show, as well as the blood circulating in them. At that stage, the development and formation of organs proceeds quite promptly

566. — In the developing foetus one can see, barely marked, the heart, the liver, the brain and the spinal cord. Shortly afterwards, the entire head and the chest is formed, and then the abdomen and finally, first slowly the hands appear, then the legs, until the entire tiny shape has been developed.

567. — At four weeks, the foetus is close in size of an ordinary fly. At that time it is soft, gluey, and seems to be suspended by the belly. At six weeks it reaches the size of a bee, but it is still quite gluey; the head is very large in relation to the body, while hands and feet barely begin to be marked. At twelve weeks is nearly three inches long and all the members are quite well marked. At four months it is five inches long; at five months, from six to seven, at six months all the organs are completely formed, while the length is from seven to nine inches. At seven months the length is from eleven to twelve inches, at eight from fourteen to fifteen, and at

the time of exit from eighteen to twenty-three. Experience shows that the pace and progress of foetal education is far faster at the early stages than at the end of pregnancy.

568. — The *place* (*placenta*) is a thick, membranous, not very densely woven organ, composed mostly of vessels, connected to the foetus by the umbilical cord, and to the uterus through a spongy membrane called the *decidua*. It is mostly composed of vessels whose branching is so fine and numerous that, after filling them with wax, they present an image of the thickest bush. The surface, ending in the umbilical cord, turned towards the foetus, is convex; the surface adhering to the uterus is concave and composed as if from follicles. All the vessels end up together and form the umbilical cord.

569. — This cord consists of two arteries and one vein surrounded by abundant gluey material, and is covered with membranes taking it's origin from the egg. The vein coming out of the placenta enters the foetus through the umbilical opening and immediately divides into two branches under the liver; one of which pours blood directly into the great vein ending in the right atrium of the heart, the other returning it to the vein spreading all over the liver, known as *vena portarum*. Arteries which form the umbilical cord begin in the foetus, sometimes from the lower part of the *aorta*, sometimes from the *femoral* artery (*iliacae*) and rise on both sides of the bladder up to the umbilical opening.

570. — The placenta can be divided into two distinct parts: the spongy or cellular part, and the intertwined part. The first is formed by spongy lining (*decidua*) belongs to

the mother, the other originates from the separation and proliferation of umbilical vessels, and belongs to the foetus, and can not be filled be wax otherwise but also through the umbilical vessels, while when the first one is not filled otherwise but through the mother's vessels.

571. — From the moment of conception, not only does the uterus continue to grow, and its vessels continue to extend and thicken, but also a new organ is created in it, an intermediary between the uterus and the foetus. This organ and the entire uterus, transformed in its composition, must process the mother's blood in such a manner that when it reaches the suction vessels of the foetus, it can constitute decent viable matter for it. Or rather, the pregnant uterus and the new organ formed in it are true organs of secretion, elaborating animal combinations capable of feeding a new foetus. The matter elaborated in this manner is probably absorbed by the foetal suction vessels or, as Physiologists understand it, by the very beginnings of veins, although it is in disagreement with the usual course of nature; the absorbed blood becomes the aliment from which the foetus perpetually elaborates all its organs. Hence, the umbilical cord and the whole placenta belonging to the foetus are similar to the trunk and roots of a plant taking food from the ground; life and growth of the foetus is like life of a species of plant, until organs intended to begin a stronger animal life have developed.

572. — But the important destination of the placenta does not end here. Observing closer the nature of vessels

constituting the umbilical cord, and the blood circulating in them, we can see that the umbilical arteries are filled with black blood which is characteristic of veins, while the umbilical vein contains real arterial blood. This perception teaches us that blood circulating in the foetal vessels, and processed into black venal blood, having been used in all organic elaborations transforms into arterial in the *placenta*, and therefore, the area must be situated in the foetus, and is an organ for arterial blood elaboration replacing the function of lungs. This replacement seems to come into effect not otherwise but by an encounter of arterial blood with venous blood within it, and granting the latter properties of the former. It is impossible to comprehend how the uterine arterial blood might elaborate oxygen and nitrogen necessary to process venous into arterial blood in the spongy mass of the placenta. The placenta, therefore, performs the joined function of the lungs and the function of the stomach.

573. — According to this method of arterial blood elaboration, the course of its circulation is different in the foetus. The bright red blood returning through the umbilical vein flows partly to the liver vessels, and partly directly into the large vein and the right heart atrium. There is an egg shaped opening between the left and posterior atrium, allowing the passage of blood straight to the latter, so that the arterial blood can flow straight to the venous cavity of the heart without passing through the lungs. Only insignificant volume of the remaining arterial blood, thrown out the right anterior heart cavity flows into the lungs being yet inactive

and in the process of formation, and whose essential function has not begun; so straight through the arterial channel connecting the aorta with the pulmonary artery, passes on to the circulation throughout the body.

574. — So, all the organs intended to receive and digest food, as well as lungs, are present in the foetus, though completely inactive. All these organs are in the process of elaboration, developing with the view of their future functions, and the placenta replaces them all until the time comes, thus satisfying the needs of animal elaboration. But watching all the manifestations of foetal life closer, we can see no excretions, unless we would like to consider waters surrounding the foetus as such, which is neither proven nor true. Indeed, some authors consider these waters to be foetal aliment, though it is equally unlikely, claiming that they are swallowed by the foetus. But notwithstanding the fact that such a way of feeding the foetus is not at all necessary, we do not observe any trace of chyle elaborated in the foetus; nor can the chyle be elaborated where the way of feeding and elaborating blood is not at all different.

575. — So, all the organs of assimilation of food and arterial blood elaboration active in the born babies and in adults are still laying intact in the foetus, for which aliment is produced by a particular organ, an intermediary between him and the mother, where the placenta replaces and cleans the lungs. For this reason, the foetus's life is different from the lives of children and adults, though the whole difference does not end there. It seems that the arterial blood

elaboration in the foetus and, therefore all animal elaboration is weaker. That is why the foetus has little fibre, and not very strong, too, and plenty of jelly and animal mucilage. In addition:

576. — Because the beginning of *individual* life means bringing the organic force to the greatest potential (156), and thus bringing the counter-organic forces to zero. Because the introduction of these counter-organic forces, or rather their first appearance, may occur only when the organizing force loses some of its elemental power by spreading in a certain mass of matter. Therefore, it is not only the matter of commencement, but even a certain length of *individual* life must pass without substantial dissipation, and without the corresponding excretions which, once they have begun, must continually intensify, multiply and grow with the passage of time.

577. — It is not to be understood, however, that because we do not observe excretions in the foetus, organic dissipation does not occur. For this case, in the strictest sense, may be conceived and supposed only in the first moment of *individual* life, in the first atom in which life begins. In other words life in the foetus, according to previously established assumptions, like in the entirety of nature, must be founded on continuous transformation of matter in a given form, and continuous transformation of the form in given matter. But because at the beginning of *individual* life, all the organs and parts thereof are yet to be elaborated, and then, their major part develop until a certain time; it is not

surprising that the matter originally used to form a foetus, intended to elaborate its organs while passing from one to another, can not become excretion material until all these organs have not formed and developed to a certain point. Hence, excretions which until certain time are non-existent or impossible to be discerned, with time must increase in number and multiply.

INFANCY.

578. — As soon as the foetus has matured in the maternal womb, i.e., the organs have developed and formed adequately, so that the infant may begin to breathe, take food into the stomach, digest, indeed, that further progress of his animal life necessitates it, then birth takes place. The mother's uterus and abdominal muscles engage in continuous and strong movements, striving to expel the mature egg. The cause of these struggles and the accompanying pain seems to be only the maturity of the egg and conclusion of the function of the uterus. You can not search for the whole cause in the uterus stretching to the highest degree, because that organ does not seem to suffer any duress during pregnancy, but from the moment of conception itself continuously experiences changes in organization. This is most evident in the swelling and stretching of the uterus even when the foetus is in the ovary or in the abdominal cavity.

579. — In infancy, the baby still lives on food elaborated by the mother, but the organ that produces the food is changed, as well as the nature of the aliment itself. What

for the foetus was the uterus and placenta, for the infant are the breasts. These glands, inactive over the entire life cycle, begin to fill at the end of pregnancy with dense and sticky fluid, and after birth they elaborate in abundance sweet and greasy liquid which we call milk. This fluid is real baby food, and in infancy no other should be used. The mother is endowed with organs which, from conception until the end of infancy, continually produce material upon which the new being develops. The first such organs are the ovaries, the second is the uterus, and the third and the last, are the breasts.

580. — Because all organs are in place in the infant's body, and most of them finally elaborated, with the commencement of this phase of life excretions begin, namely stool and urine, as well as skin and pulmonary excretions. Shortly after birth, the blackish matter, known by the name of *meconium*, which is obviously a kind of faecal combination, accumulated in the bowels before birth, is excreted with the stool. From that moment begins the elaboration of bile which flows into the intestines, though pale, weak, and watery; henceforth all animal elaboration begins to be stronger. The activities of sensory organs and the brain are accompanied by gradual development of mental powers, and continuous growth and improvement of the nervous system and muscles. From then onwards, sleep is interrupted by frequent and prolonged periods of alertness.

581. — All organs which in the foetus replaced the functions of lungs and the digestive tract, deemed unnecessary after birth, wither in the infant's body immediately or in a

very short time. For example, the umbilical cord and the placenta become dry and fall off, the egg-shaped opening between the two atria closes and overgrows, as well as the arterial and vein channels. Once the newborn baby takes the first breath, and blood begins to circulate through the lungs and begins to change into arterial, the mentioned channels become unnecessary. Once the placenta has separated from the mother, breathing and constant connection with the air become a lifelong indispensable condition of *individual* existence.

582. — Infancy lasts from birth until the end of the second year of life, namely until the primary teeth are completely developed, and when muscles have grown enough to give the baby the skill and strength to crawl, and then to walk; in whom, due to the fact that the teeth are already formed and digestive organs reinforced, the mother's milk is now replaced by weaker animal food and, finally, plant food, and therefore the *individual's* existence is dependent on the parents only because of the weakness of the body. Henceforth all physiological bonds between mother and foetus cease, and their place is now occupied by moral bonds.

583. — The primary teeth usually appear from the seventh month after the birth of the month until the end of the second year, and last until the seventh. The *individual* differences in strength, constitution, and the rate of life may sometimes delay or accelerate the process. The number of these teeth does not exceed twenty: that is, ten in each jaw. The front and upper appear first, then front and lower,

followed by the fangs, and finally the two molars teeth on each side and in each jaw. When molars have teethed, deciduous teething is complete.

FURTHER DIFFERENCES RELATED TO AN AGE.

584. — From the time of separation and the beginning of childhood, a person, partaking in beverage and plant and animal food, begins to be in nearly such relationships with the rest of nature as he is to remain for the rest of his life. However, just as every organic being, he can not feed on all viable matter, but only on certain combinations thereof; it may also be considered that in different periods either only some organic combinations can serve him, or some better than other. In his beginnings, for instance, conceived in a drop of fluid, he elaborates solely from animal combinations prepared by the mother, and is protected from any access and influence of the air. After birth, he still feeds on mother-elaborated combination, namely milk, until the organs designed to receive and digest food slowly develop and strengthen and will little by little dispose for the weaker animal and vegetable combinations. But in this period of stronger animal production, the influence of air becomes inevitable.

585. — And since the viability of food as a relative and differing property is determined by the position of animate entities in the chain of organized beings (166), therefore man

in various periods of his life naturally changes his relation to viable matter and to organized entities.

586. — This relation, of course, is based on the fact that in the first moments of life only well elaborated matter is processed, easily assimilated, slowly and gradually, and man proceeds to elaborate increasingly more difficult matter to process. Taking into account the order established in the entire animate nature, we can see that not only he, but also more perfect animals feed on maternal milk for some time. Birds, which develop in eggs composed from two strong animal combinations, that is, yolks and whites, are fed after birth with animals or plants that have already been partially digested in the parents' stomachs, softened, and mixed with specific animal juice. Even the plant foetus, at the beginning of *individual* life, feeds on plant combinations contained in the first leaf seedlings. Clearly nature, commencing animal and plant life, in more or less elaborated combinations, having once established the existence of a new *individual*, and initiated the course of his life, gradually feeds him to assimilate less and less processed beings. Or, speaking a language accepted among us: *individual* organic force is exerted on the matter more viable, the more it expands.[70]

587. — And since this degree of nourishment for every living being differs, as it is based on the place in the chain

70 Viability is considered here in relation to a whole range of organized beings, as in § 164.

of organized beings, so the whole development of a decent maternity in the mother may depend on bringing it to this only the necessary degree of viability.

588. — The primordial age difference is that man, like all organic beings in general, is capable of processing matter the more viable, and therefore taking longer to elaborate, the further he moves away in time from the initial moment of conception, and on the contrary. The less expanded the organic force is, the more it is active. This is why it transforms and assimilates the properly prepared matter entering the area of its operation more rapidly, but by the same token it requires the more frequent supplies. Thus, the essential speed of action is primarily maintained owing to the fact that the supplied matter is easy to process, and thus the processing requires less time.

589. — It is, therefore, in the nature of the organizing force that the less mass of matter it contains, the faster course of life it must maintain, that is, the rate of life in *individuals* is in the relation of *concentration* of organic force. So, this rate is the strongest at the very beginning of *individual* life, gradually weakening as time goes by, and is maintained, in accordance with the assumptions of this lecture (168–313) thanks to matter at the beginning elaborated the strongest, and then less and less strongly. Experience confirms the above, and fully convinces everyone.

590. — The rate of life is best felt in the rate of renewal, and therefore, in frequent or rare need of food and drink, and the swiftness of blood circulation and animal warmth.

That is why we observe that, in the foetus, the blood flow is curiously fast and viable matter is supplied continually. After birth, the circulation slows down, but gradually, and the need of aliment is still quite frequent. With age, blood circulation and animal warmth become weaker, and partaking in food less frequent and less abundant.

591. — One of the most serious differences seen at various times in the course of life, both human and of all living beings is the varied solidity of organic parts which, with the progress of time, perpetually harden. We can see that life begins from a drop of fluid in which it slowly creates, elaborates and determines the solid parts, one after another. All these parts, including the bones, are soft until birth; this softness gradually decreases in childhood, where we perceive, naturally, that more and more clotted parts develop, and then, they harden and become stronger and stronger. Such hardening continues until very old age in which many soft parts acquire toughness, to finally completely ossify.

592. — This tendency of fluids to solidify and soft parts to harden occurs in all nourished beings. The obvious example of this is in long-lived plants, in which the amount and the hardness of fibre constantly grow with age. Everybody is familiar with the fact that young plants and animals are soft and sticky, as well as with the fact that the old are hard and tough. What should be added to this is the observation that all solid parts, both in animals and plants, are made from liquids, and the ailment even of the former, before it can be properly elaborated, must first be turned into various fluids

and, finally, into blood. These organic clotted parts are thus elaborated from the same fluids, and become the harder, the longer life continues. Therefore, it should be admitted that the entire exertion and pursuit of life is to continually solidify the matter in which it takes place. And it ought to be conjectured from the above that organic beings ultimately seek to reduce the volume of volatile and liquid bodies, and multiply the hard ones on the terrestrial globe; this seems to be confirmed by huge deposits of organic corpses in the fossil kingdom.

593. — But as hardening of the nourishing matter is tied to its elaboration, organic growth must have the opposite effect. Organic beings enrich the fossil kingdom only with clotted corpses, burying in it and hiding water and air transformed into solids. While still alive, exuding the most water and gases, of course, both use liquid and volatile substances but, on the other hand, they recreate them again. But, in the whole physical world, what nature creates on the one hand, it recompenses; and therefore, as we have shown elsewhere (98–100–101), the remains of organic beings in the fossil kingdom dissipate again and return to the liquid or volatile state, thus returning to life, yet again for the benefit of organic beings.

594. — Returning to age-related differences, of course, it is clear from the preceding observations that there is a greater abundance of fluids in the young than in the adults or the old. So, from conception to the meridian of life, liquid parts still have an advantage, just as solid parts from the meridian

of life until death. And because the rate of life, which is the fastest in the foetus, constantly decreases with its progress, similarly, the degree of hardening of organic parts increases, so the power of hardening and the solidification of organic parts runs at the opposite rate to the pace of life. Experience obviously confirms this truth. We can see it in that perennials, whose pace of life is very slow, form the most fibre and are the hardest, while those plants which emerge, ripen and die almost before our eyes, like nearly all mushrooms, form the lest fibre or none at all.

595. — Considering the most agreeable relationship between the organs and body parts in the human being at that time when they are all fully developed, that is, in mature age, and referring their size and proportion in childhood and infancy to this relationship we shall observe, of course, that the head is still larger over that proportion from birth to the completion of growth. On the other hand, contemplating the order in which the organic parts are formed and developed, we can see that in the foetus the head is first to develop, and is far larger than the other parts. Thus, with regard to the nervous system, whose centre and accumulation is in the head, it appears that this system is the most abundant in the foetus, in infancy and childhood, significantly exceeding the ratio characteristic of later life. This prevalence of the neural tissue makes the children and young people much more sensitive than the adults and old. With the advancement of age, in the same relationship in which the muscular system develops, forms and strengthens, the

prevalence of neural tissue decreases, and consequently, so does sensitivity.

596. — Such a permanent reign of the neural tissue shows that its elaboration always prevails over dissipation, and this prevalence is the stronger, the younger the age, what is well proven by almost uninterrupted sleep in the foetus and very long and frequent in infants and children. After birth, although periods of alertness are very short, nonetheless directly combined with activity of the senses and the influence of the external objects. At this time, the intangible function of the nervous system begins, and its dissipation slowly begins to increase, too. Through the action of the senses we slowly acquire images and representations, and in relation to this acquisition other mental powers are uncovered, thus intangible activity of the brain grows. In the same relationship, the length of sleep decreases and the activity of the muscles increases, which even more helps the proliferation of neural dissipation. The more perfect and strong the muscles are, the more powers of the mind proliferate, and neural mass enters decent relationships with the rest of the body. One may conclude from the above that, generally, children and adolescents have nervous temperaments, a condition which can remain for a lifetime decent education does not prevent it.

597. — Such abundant elaboration of neural tissue, driven only by the *individual* power and viable matter supplied by blood must make the nerves most sensitive to all external stimuli and most apt for all intangible activities. *Firstly*,

there is always plenty of matter that may be elaborated; *secondly*, the neural tissue is more receptive to the external sensations, and the less the sensations, the less it receives. Hence, the images and representations acquired in childhood and youth are the purest and the strongest, as in later years they are purer and stronger the less we have them. This is the real reason why children have such a strong memory, a faculty lost over time, the more knowledge they acquire. Hence, it is not surprising that the ancient peoples, unruly and little acquainted with the arts and science, have much purer and stronger images and representations of themselves and common objects than refined peoples and, therefore, images painted in their speech and writings are so lucid, powerful and delightful.

598. — For the same reason, other mental powers requiring a certain amount of imagery are weak in children and adolescents until certain age. Likewise imagination and reasoning. The latter must come later than the former, which necessitates only a strong sense of zeal and a certain amount of imagination when reasoning, not only expected to associate ideas and relationships but even to judge their conformity or non-conformity with nature, and to deduce the rules of conduct in accord with the greatest good of man, needs far bigger amount of representations, but also relationships. That is why imagination is abundant in youth and adolescence, when true wisdom and reason barely awakens.

599. — According to the observations of Anatomists and Physiologists, lymphatic vessels are far more abundant in

children and young people than in adulthood or in old age, when a major part of them closes completely and dies. This is one of the reasons why in children there are far more fluids, especially sticky ones, compared to adults. It is because of this abundance of lymphatic vessels, dissolving and swallowing solids and, therefore, their renewal proceeds much faster and the rate of life usual in youth, so does the cooling process which is maintained at the equal rate to the warming process. But, on the other hand, this prevalence and activity of the lymphatic system is a predilection for some characteristic diseases, namely inflammation and suppuration of vessels and lymphatic nodes.

600. — And, as all organs develop and form in sequence, this sequence is really necessary because its first members are necessary for the existence and development of the next, by the same token early development and spreading of the nervous system is certainly needed for the development and improvement of other organs. The above grants new support to our previous concept that muscle systems are elaborated and perfected largely at the expense of the nervous system. Proof of this is the great sensitivity of children with simultaneous complete inability of movement, and the unchanging perception that the more the muscle system grows stronger and abundant, the more the nervous system is digested, and sensitivity enters narrower realms.

601. — In youth, however, the prevalence of organic elaboration over dissipation, though most intense in the nerves, takes place not only there, but in the whole body. This

prevalence is the cause of growth and continuous spread of the organization. For the same reason the excretions, which in the foetus are thought to have been negligible, proliferate after birth and multiply in old age. As we often see that in late maturity and in the old age, new and unusual excretions occur and persevere, and which, in the end, become equally important to maintain good health as ordinary excretions. Such as, for example, bowel movements accompanying haemorrhoidal veins, coughing out dense phlegm in old people, leg ulcers and the like. And these excretions are increasing and multiplying at that time when the need for food and sleep is decreasing. Even urine in the older age is more saturated than it is in children, richer in urine and uric salts.

602. — We have seen, in addition, that in the foetus the function of lungs and organs for chewing and digesting food is non-existent. Although the lungs begin to be active immediately after birth, but this activity is poor for a long time, and the blood is pale and thin, with poor animal characteristics. The lung function and the degree of animal elaboration develop and perfect and growing which causes a higher degree of elaboration and a greater abundance of nitrogen in excretions, as proven by the state of urine, excrement, and transpiration. The latter has, in mature people, far more powerful animal smell, and in the elderly even intolerable.

603. — Similarly, the entire set of digestive tract organs, completely inactive in the foetus, after birth is capable of digesting only milk, and then only better elaborated foods, closer to the animal nature. Even the digestion juices,

namely bile, do not have the power in children which they later acquire. And so, these organs continue to improve and strengthen until complete maturity.

604. — From what we have said about age differences so far, it seems that children usually excel in superfluous sensitivity and abundance of fluids, namely the lymph, the fast rate of life, poor digestion, poor animal production, weak muscle system and excessive softness of all solid parts. Such a constitution can easily lead to their predisposition to certain types of illness, and to decent prescriptions for their physical education.

605. — As young people have passed the age of infancy and childhood, the predominance of nervous system begins to diminish, but the system of blood vessels starts to proliferate and take advantage, arterial in particular. The proof of this is the considerable animal warmth, deeply red colour of blood, strong beating of the arteries, blushed cheeks, and a strong tendency to fevers, inflammation and arterial haemorrhage. It is this abundance of the arterial system at this stage of human life that *Wintringham's* experiments tried to prove. This proliferation of arteries causing the promptness of blood circulation, and connected with strong sensitivity and great flexibility of all organs is the cause of liveliness proper for this age. The activity of arterial system seems to be most strongly dependent on strong animal elaboration, namely of arterial blood. It takes place in the lungs, therefore juvenile age is connected with particular strength and activity of this organ. This is why this age is the period of

inflammations and pulmonary haemorrhages which so often end in fatal ulcers.

606. — The juvenile age ends finally with the development and commencement of the activity of genital organs which, until now, have been completely inactive. Their development seems to be associated with stronger animal elaboration and predominance of the arterial system. The development of the genital organs is followed by elaboration and perfection of muscles, and thus introduction of many changes into the animal economy, partly dependent on the strength of muscles, and partly on the genital organs. These changes are more significant in men, and are articulated in darkening of the colour of the skin, lowering the pitch of voice, appearance of body hair, with hair being most prominent on genital organs and the face, emergence of considerable strength and courage, and eagerness to connecting with the opposite sex, which often manifests itself in a very strong passion called love.

607. — Strictly speaking, the genital organs are not part of *individual* life and can be completely removed. However, because of the erotic life depends on them, and is tightly knit with *individual* life, it obviously influences the former, thus by removal, damage or rendering those parts inactive, man abandons all erotic relationships and thus loses part of the influence of the surrounding beings onto himself, and his life becomes limited to a far narrower range of phenomena. In addition to this, the genital organs, being associated with the entirety of the living *individual*, who feeds on the matter

elaborated by them, and the newly elaborated matter is returned to him must, according to what we have said (251), affect *individual* lives and be one of the causes of energizing and improving those lives, and thus, they can not be lost without damage to the *individual*, some of his organs and manifestations of life.

608. — These observations must be supplemented by the remark that the complete development and functioning of genital organs do not delineate the definitive term of *individual* development and perfection, and therefore, damage to them must halt the formation and improvement of subsequent organs and phenomena of life, or at least weaken them significantly. That is why we can see that the eunuchs retain, so to speak, youthful age, wherein their organisms age but do not perfect and reinforce in the same way as those not castrated.

609. — The most obvious phenomena of life that appear just after the development of the genital organs, especially the male parts are: the loss of original whiteness and the softness of the body, lowered pitch of voice, considerable strengthening and growth of the muscles, courage, hair covering of the whole body, especially the face. Therefore eunuchs, in whom the manifestation of those changes is halted, retain youthful whiteness and gentility, high pitched voice of a child, their faces are free of hair, they lack courage, and their muscles are weak, soft, and sagging.

610. — After complete development of the genital organs and the end of adolescence, all the animal parts already

established and active, they only reinforce and perfect until their full maturity, that is, to the meridian of life. The skin and entire cellular membrane thickens and acquires more elasticity. The superiority of the nerves and the arterial system ceases and both systems enter decent boundaries. Above all, the muscles perfect and become very powerful. This is why that period of life is an age of strength and of courage. This is the age of soldier spirit, of the desire to rule and conquer, of love and glory, in short, the age of undertakings and the greatest activity in every domain.

611. — This age ends exactly at the meridian of life, which in men is about 35 years after birth. In this whole period which can be called the epoch of most perfect life, all organic systems are in a decent balance, or at least in perfect condition. The nervous, muscular, arterial and venous systems are in the best interrelation, and the activity of one is perfectly balanced, ideally matched with the activity of another. The man is everything he can ever be; though from then onwards begins a gradual decline; the perfect and most favourable relation between the living systems begins to change and again, though in another order, one gains predominance over the other.

612. — But, *firstly*, the nervous systems which, until the meridian of life, maintained continuous or decreasing advantage, henceforth loses more and more of its power and is less active. This decline is not significant in people endowed with nervous temperament, not so evident in hot climates and in women, but in other temperaments in temperate

climates, and particularly in hardworking men, it definitely is noticeable. The arterial system, which dominated from youth until full maturity, begins to lose this advantage. Owing to the rate of blood circulation and the animal warmth, the tendency to the arterial haemorrhage and inflammation slowly disappears, on the other hand, the venous system begins to proliferate and apparently dominate, the above is proved by the size of veins and the tendency to venous haemorrhage.

613. — And because the most prominent part of the venous system is the vascular system of the liver, therefore every change occurring in the former is best reflected in the latter, so at the age past the meridian of life, when the predominance of the veins begins to establish, the first signs will present themselves in the fullness and swelling of veins, at the confluence of which the major liver vein appears. In this case not only the liver itself begins to suffer through this fullness, where the signs are obviously manifest. Not only does the liver become vulnerable to some diseases, but all abdominal organs, too. The first effect of the overfilling of abdominal veins is swelling of the haemorrhoid veins and excretion of blood through these vessels, and disposition to various types of abdominal diseases, about which we shall talk in greater detail elsewhere.

614. — As predomination of the arterial system inclines towards all types of thoracic diseases, the predomination of the venous system leads to abdominal distress. Thus, we can easily explain the perceptions of the old doctors who

thought that the age of childhood inclines to head diseases, youth to the chest diseases and mature age to abdominal ones. In *old age*, the arterial, lymphatic, and nervous systems weaken and begin to abandon their former functions. Of course, sensitivity slowly changes, some of the mind's powers are reduced, memory is blurred, imagination and passions freeze. Even the power of reasoning itself becomes greatly reduced. Only sensibility, which is the result of long experience and cold deliberation, persists in all its power until almost to senility. The sluggish action of the arteries slows down the whole course of life and animal warmth; hence, the greater the need for external heat, less arterial blood elaboration, weaker function of the lungs, and all the animal elaborations based on arterial blood become weaker. The reduced lymphatic vessel function leads to a reduction in dissipation of the solid parts and swallowing of liquids. The result of the first is increased hardening of these parts, and of the second, the collection of various fluids in cavities and in cell membranes, namely, initially the fat and, finally, water.

615. — In the later phase of the old age, and even more so in the age of senility, less and less fat is elaborated, which is why it slowly decreases in volume and finally disappears. The bone matter alone seems to dominate more and more which is clearly not only due to the brittleness and increasing hardening of the bones, but also owing to the obvious deformation of some of the softer parts of the cartilage and arteries. Meanwhile, with gradually disappearing of

sensitivity and less opportunity of movement, fluids visibly wane, the smaller vessels, both blood and lymphatic close up and blur, the entire body dries out and shrinks, the heart's power, the strength of the lungs and the animal heat diminish more and more, the powers of the mind diminish gradually, until finally the whole body, cold and inert, dries up resembling a mummy, and the organizing power, exhausted to the highest degree will perish. This is a decent and inevitable end of human life, which is most often accelerated by violent causes.

CHAPTER XL

DIFFERENCES RELATED TO SEX.

616. — Man and all the more perfect animals consist of two *individuals* of separate genders: male and female. The essential difference between these *individuals* is in the genital parts, different in each gender. Where this separation has not taken place, there is no difference between *individuals* of the same species. Nonetheless, in separated *individuals*, the development and full activity of the parts comes quite late, and the gender dissimilarity does not make any difference between them in this period. Therefore, in the foetus, in infancy and childhood, we do not observe any differences between *individuals* of opposite sex, there is the same constitution, power, tendencies, and all the phenomena of life are quite the same. In short, apart from the initial formation of the genital parts, these two *individuals* are quite similar. If then, at a later age when the genital parts have been fully developed and are active, we will find such a great number of disparities in the whole composition of the body, the constitution, tendencies, and behaviour, we can conclude that all the differences should be attributed to the activity of genital parts and their influence on the constitution.

617. — The female and male parts taken together constitute a single organ, because their full activity takes place at and fulfils destiny when they are united. But since in this combined activity, each part of itself has its own contribution, it has a separate manner of activity which may be regarded as twofold: it is the action of one genital exerted on the other, as well as the action of either the entire organ, or of each part thereof on the *individual* organs and constitution. What should be kept in mind about the reciprocal activities of the genital organs, we have already mentioned elsewhere (130–141). What remains to consider is how each part of this organ influences the parts and constitution of the *individual* to which it belongs.

618. — We have already mentioned (607) that the genital parts, though not placed in the sphere of *individual* life can, however, influence the *individual* constitution and vice versa. The real and important generic organ in the female is the *ovaries* (*ovaria*), and in the male the *testicles*. If those generic organs are removed, the whole generic activity and the fertility cease. The ovaries initiate, secure growth and maturity of eggs, while the male organs elaborate animal fluid which fertilizes them. The other parts of genital organs are only supplementary, and either facilitate and bring about the function of the former, or serve as a way of uniting the two sexes or, finally, preserve the fertilized egg until complete maturity. Such an organ is a female uterus which holds the fertilized eggs, protects the budding foetus and provides it with decent viable matter.

619. — Male semen is a particular kind of organic fluid, elaborated in the testicles, whose specific and quite complex structure bears no resemblance to glands. The fluid itself is elaborated very slowly, and is often stored for a long time; it becomes an excretional liquid, if it is not used for fertilization for a long time. It is thicker than other animal fluids, viscous, and has a characteristic, powerful smell, is full of tiny microscopic worms, from which some Physiologists and Naturalists derive the origin of man himself. Ejected from the body, it is always mixed with another, more fluent, milky liquid produced in the *prostate*, a gland of quite considerable size, situated at the neck of the bladder. Does the latter liquid have any significance in fertilization? If so, what? — this is unknown. Nonetheless, it does not fertilize on its own — that it is quite certain from experience.

620. — Elaboration of this fluid, beginning at the age of around sixteen or eighteen, and perfected around twenty-four, is the reason for significant changes in the animal economy, which we have already spoken about earlier. The most important of them is the beginning of a generic life, giving a new *individual* being a new drive and new direction, and thus, establishment of a new source and new stimulus for activity, and simultaneously, a change in many aspects of earlier activities. The principal pursuit of an *individual* is only to maintain personal integrity and provision of viable matter, by the same token, the generic pursuit is to appropriate for oneself the opposite sex. This pursuit and aspiration

may become not only a passion, but even a source and excitement of many other pursuits.

621. — This generic pursuit is different in various *individuals*, and in some so violent that it destroys and blurs the great part of *individual* aspirations, metamorphosing first into prevailing passion and then into madness. It is no wonder then establishing the generic activity, being such a great incitement for all sorts of undertakings and muscular activities, evokes their perfection and strengthening.

622. — And as the power of each organ and system in particular is based on its proliferation and superiority over other parts of the same organic being, similarly, the proliferation and power of the generic system must be the cause of impressive generic activity, always with the detriment and disadvantage to other systems, and thus, to all *individual* activities. With age, since this abundance of generic parts, the strongest excitement of all activities in such *individuals* ceases, the man becomes indolent and inactive, and a true burden to himself. But if the generic systems do not surpass decent boundaries of activity and do not harm other organs and systems, even though its activity decreases or ceases, the activity of other organs follow their established order, and the entire pursuit of the organic being returns again to *individual* aspirations.

623. — Thus, the new and brave encouragement for movement and activity gives the young man, in whom it is discovered, the new life and mobility, keeps the entire muscle system in operation and active, strengthens it and

maintains its power, especially when conquering the female heart which is a difficult task, is infrequent and brief. But the certainty of possessing what one wants from the opposite sex according to taste and beyond satiety, indeed, leads to inaction and effulgence; its frequent and superfluous use only maintains the intensity of the genital organs to the detriment of others. Abundant elaboration and loss of seminal fluid exhausts the blood, returning the viable matter to the organism, to the detriment of all other organic elaborations. Hence, in the lustful and lecherous people, there is weakness of the body and mind, followed by bad digestion, exhaustion of muscles and the predominance of the nervous system, perpetually employed and tickled. Hence, *Lycurgus* justly and very wisely allowed the Spartans only brief and secret visits of their wives. This is the major source of softness and inactivity of the Asians, and youthfulness and fortitude of the European youth, though even here corruption of conduct and excessive freedom granted to women promises to make us like Asians.

624. — Lust and strong attraction to indulgence are usually the result of the superiority of the arterial system, introducing liveliness and the power of blood circulation, animal warmth and all organic elaborations. Surrounding oneself with women and indulgence in lust only returns the majority of this activity to the genital organs and exhausts the body rather than in this, and not another manner. Those who attribute all the activity and male power to the *absorption* of semen and its entry into the blood, ignore the fact

that it is an excretion fluid which in abstinent men is ejected on its own at certain times, that its overflowing and fullness not only does not give more strength and power, but is also cause fatigue and sullen humour.

625. — In females, the most important generic organ are the ovaries; the second, almost equally important, is the uterus. But the whole generic activity depends on the former; because following the removal or damage to the ovaries, this activity ceases completely. Women mature and become fertile earlier than men; in our country usually at the age of fifteen or sixteen, and in hot countries at eleven or twelve. The external signs of their maturation are: rounding and filling of breasts, hair covering the pubic area and, finally, initiation of monthly excretions. At that time, the whole body becomes curved, elaborating more fat. The voice changes and, at the reminder or sight of a man, cheeks blush rapidly. In short, it is the age of two of the most beautiful attributes of the fair sex, alien and unknown earlier, namely, modesty and shyness.

626. — In general, women's muscles do not have the strength of men's; women are weaker, more sensitive and fearful. Their genital parts do not induce them to any activity, to seek, to appropriate or conquer the opposite sex, but rather to quietly surrender or pretend defence. This is why inactivity, modesty, sensitivity and softness of the body and mind are the hallmark of that sex. Their skin is thinner and more delicate, both arterial and venous, the vessels are far more extensive but less strong, the lymphatic vessels

are more numerous. Hence the continual prevalence and abundance of fluids, hence the tendency to haemorrhages, hence, on the other hand, the fact of loss of fluids does not harm them as much as men. The abundance of fat filling the cellular membrane everywhere and tightening the skin, gives it a smooth roundness and pleasant shine. But this very abundance of fat proves that animal elaboration is weaker in them than in men, therefore the weakness of their muscles. This softness and weakness, combined with the abundance of juices, leads to a stronger elaboration of the nervous system and increased sensitivity, which women are masters of. Their temperament therefore is, in general, nervous, lymphatic and sanguine; while men, sanguine and athletic. And in that there lies the whole difference between men and women with regard to constitution.

627. — In our climate, the monthly excretion usually begins at the age of fourteen or fifteen, preceded by the development of breasts, and its very emergence is heralded by slight fever. The source of this excreta is the uterine vessels, at that time stretched by a stronger influx of blood and more active. At that period, the whole generic system reddens, swells, and acquires more sensitivity. This swelling and overflowing with blood must be much more significant in the uterus as an organ almost completely woven from vessels; and since most of these vessels end up in tiny openings in the cavity of the uterus itself, the overflowing is evacuated into it, and thus the swelling ends. It can not be doubted that the periodic increase in the activity of the genital organs and

the abundant blood flow to the uterine vessels are the most probable cause of the monthly excretion. But Physiologists have also tried to find another cause of this periodic swelling.

628. — Experience has shown that women gestate during the time of excretion and become pregnant just before the excretion arrives, or soon after its disappearance. So their period of excretion is a period of ability to conceive. This fact becomes evident when we consider animals, whose females mate at the time when they are capable of fertilization, and this is quite similar case. And so, does are subjected to real blood excretion and visible swelling and warming of genital organs when they mate; the same can be observed in bitches on heat. Mares, just like cows, ooze reddish fluid from swollen genitals once a year, and this is the period in which they can be fertilized. If, in women, the menstrual period is far more common, the cause may be that they are more often ready for pregnancy. There can be no other source of this ability but maturation of an egg, or readiness for its fertilization, though the reason for it is not known. That it is true, we can see on the example of a simple experiment on animals; following removal of the ovaries, both the capability for gestation and periodic swelling of the genitals, coupled with excretion of moisture, immediately and forever ceases.

629. — Finally, experience proves that in all nature, females mate at certain stable periods, and are then capable of fertilization. These periods and this capability can not depend on anything other than the maturation of eggs at certain designated times, because only eggs can be, and are

fertilised. Finally, menstruation appears only when females mature and become capable of gestation; it disappears when this potential elapses; menstruation appears only when females are ready to become pregnant. So of course the effect of the ovaries on the whole constitution is paramount, and especially on the uterus.

630. — In women who live in the company of men and surrounded by men, enjoying all comforts and joys which accelerate the course of life, the first period of maturity, and the appearance of menstruation comes earlier, and the succession of these periods may be more frequent, and menstruation itself, owing to stronger generic sensation and larger volume of blood, far more profuse. In the age in which we live, especially in the more refined part of society, we see that ladies, spoiled and ruffled by the comforts of life, maintaining more intensive activity of generic parts, due to constant companionship and flattery of men, their whispers tickling female vanity and, above all, by perpetual recollecting of love scenes in theatres and romances or by fussing over the non-existent events of romantic heroes and martyrs, the ladies whose monthly excretions are very frequent and abundant, and extremely easily developing in discharges of different colours. The major part of our ladies menstruate every other week, and the discharges of white matter are almost continuous and plentiful. Physicians burden them with medications and are surprised by the immense stubbornness of this disease, unable to see the true cause of these sufferings, not recognizing that they are a natural and

necessary result of a way of life which none of their female patients would ever want to alter.

631. — With age, when all generic activity ceases, these excretions cease, too; which usually happens between forty and forty-five years of age; although there are examples of women losing the regularity far earlier or far later. From then on, everything returns to *individual* existence, henceforth every difference of gender is lost, and old women are almost no different from old men, that is, if we disregard habits acquired at younger age.

632. — Menstruation halts in pregnant women. We count pregnancy from the moment of gestation, or fertilization of the egg. Usually, the fertilized egg ruptures from the ovaries and passes through the *Fallopian* tubes towards the uterus, except for some rare cases where it remains in the ovary or in the tube or falls into the abdominal cavity. Having found the inner surface of the uterus, bristling with the fine ends of vessels and full of juices, it immediately adheres to it and becomes a stimulus to all the changes which this organ undergoes during pregnancy (571). These changes are nothing but its continual growth, emergence of the temporal membrane and the transformation of this inactive organ into the organ of very important animal elaborations (563).

633. — The condition of the uterus during the monthly excretion seems to be similar to the condition of pregnancy, and is the introduction to it, and therefore, the disposition to adopt and feed the fertilized egg. In my opinion, since

the pregnant uterus becomes a true secretion organ, each monthly period is a commencement of this activity induced by the action of the ovaries containing the mature egg. And because this secretion, designed as ailment for the egg, can not be used without fertilization, it becomes material of excretion.

634. — Such a significant change in the state of the uterus, its continuous development and transformation into a very active organ, redirecting a large volume of arterial blood to itself, such excellent elaboration of blood in its walls and in its cavity, must have the greatest impact on the whole animal economy of the pregnant women, and thus, on the condition of all other organs and organic elaboration. Hence the numerous and incessant changes and sufferings that we observe in pregnant women from the moment of conception, which we can not wonder about here.

635. — When the foetus, encapsulated in the egg, reaches maturity in the maternal womb, the childbirth takes place, consisting in expelling the egg with the foetus and the placenta. Physiologists see the cause of the following pain and childbirth itself in stretching of the uterus, which now can not stretch any further, and thus in stimulating this organ to shrink and dispose of the burden. Nonetheless, the uterus should not experience any duress during pregnancy, as we have already advised above. If it, indeed, suffered any duress, then the attempt to relieve this suffering should rather occur in the very beginning of pregnancy than at the end. Therefore, the uterus disposes of the foetus rather because

the whole circle of its transformations, which can not be unlimited, ends at that time, making all possible attempts to return to the original state. Even after expelling the foetus the uterus continues to shrink, the stretched vessels continue to shorten, and partly do not take in new fluids, partly discard fluids through by the ends opening up on the inner surface of the uterus.

636. — With the birth of the foetus the whole function of the uterus ends, but its relationship with the foetus does not cease completely. Because from the moment of conception until birth, the womb has been the body elaborating food for the newborn, likewise, after birth, it begins and establishes the elaboration of the nourishing fluid in another organ, namely in the breasts, with the only difference that a newborn baby, with already developed organs fit for receiving and digesting food, takes this new aliment by mouth, digests it and properly processes into chyle. This subsequence of function of the breasts following the function of the uterus was also attempted to be explained by Physiologists and Physicians in terms of the relationship of the uterine vessels, or the branches which supply the vessels with the breast vessels; thus, by transferring in full to the latter, if the role of former ends. But the vessels and nerves of the entire body connect and communicate with each other, and the subsequence of organic activity in the whole course of existence and the animal development, most apparent in such a connection of vessels and nerves can not be explained.

637. — Mother's milk is a fatty animal fluid, consisting of real oil which, when oxygen is extracted, thickens and changes into butter, a strongly animal combination called the curd, and a special type of sugar. Besides, it contains some calcium phosphate and sodium phosphate, as well as a little kitchen salt. All these elements are important for the animal economy, and therefore, the liquid containing them must be very nutritious for the new being. The milk, introduced into the stomach, first curdles and turns into real curd, which is then slowly dissolved in digestive juices and, in the manner of other aliment, elaborated into chyle. The first milk elaborated after childbed is slightly laxative, which is necessary to expel the infant's black excrement. Then, it is very liquid, sweet and low in oil. The fluidity and sweetness gradually decreases, and the amount of curd and fat grows at the same ratio. The milk produced by animals living on plants is far more fatty in comparison to that obtained from animals which feed on meat. The nature of food greatly affects its properties; obvious examples of the above are in domesticated animals.

CHAPTER XLI

DIFFERENCES BETWEEN PEOPLE RESULTING FROM SOCIAL RELATIONSHIPS.

638. — Human needs and, in consequence, necessity, namely the convenience of mutual help, have brought people together. These original and essential needs are as follows: an inevitable need for viable matter and securing its use, protection against harmful and unpleasant elements, and the generic need for access to the opposite sex. The first of those gave rise to the notion of property and the establishment of governments and laws; the second one also gave rise to the type of industrial property, that is buildings and clothing; prompted to certain kind of organizing acts; and all needs together led to the rise of civilization, crafts and sciences.

639. — So, the principle of social union is property and its protection, and the main pursuit of all members of that union is accumulation and provision of viable matter (54), that is, acquisition, maintenance, and multiplication of property. This is the source of all human interrelations resulting from shared and reciprocal pursuit of this matter and comfort of life. And, as all human relations with the

surrounding physical world are called physical, so all his social relations, or relations with beings akin to himself, are called moral relationships.

640. — The social relationships, the need of employing them to secure individual ownership, the versatility of human strengths and opportunities rooted both in flesh and mind, are the source of social inequality between men — twofold in nature: embracing wealth and significance. In the first respect, all men can be divided into affluent, prosperous and poor. In the second, divisions depend on the nature of national government and positions upon which people are placed, stemming partly from governmental needs and partly from prejudice. The divisions are numerous, and rungs of the ladder are slippery. Generally, one part rules and the other is subordinate; one part is either coercively or truly respected — the respect stemming from reputation or honours — while the other part lives in humiliation and even contempt.

641. — The wealthy class enjoys nearly the same way of life across all countries and climates. Considering all comforts and fancies, they are soft, inactive and dissolute, while severity of the climate is beyond them because they choose only the most pleasant of climates, they are protected from the heat as well as from the cold. Never ending balls and parties, pomposity, splendour fuelling pride, privilege, elevation, popular acclaim fostering vanity, all that keeps the nervous system in constant hyperactivity; connected with nervous agitation and intense nervous activities stemming from the

theatre, gambling, romance, love affairs, jealousy, competition for grades and glory, greed, and the like. Hence the rich have a generally nervous and sanguine constitution, at least until their indulgence overstrains and weakens the digestive organs. If their comfort of life is not combined with sluggishness, their rate of life, owing to strong, abundant and spicy meals, liquors lifting the spirit, always pleasant outer temperature, indeed, owing to strong nervous system, will always be accelerated. Hence, it is easy to deduct the types of illnesses and sufferings which they are subject to.

642. — On the contrary, the poor class, perpetually struggling with all the discomforts of life, have no other way to survive but by manual or clerical work. This class is tormented by the severity of climate, frost and heat, dampness and poor clothing, hunger and thirst, contempt and despair are their friends. Indeed, in the countries in which so far slavery exists, so common in the past, hard labour, hunger and the most terror are almost only property of those miserable people. In such a class of people, the nervous system is completely neglected and inactive, indeed, it would be almost non-existent if not employed and elevated by religion; their muscles would be abundant if those paupers had enough decent viable matter from which to produce good blood, which is essential material for elaborating muscles. Nonetheless, those representatives of the poorer classes who do have work and do not experience poverty and hunger, give us the purest examples of athletic constitution. In well governed countries such are farmers and a major part

of craftsmen. But if in those people work is the source of strength, robustness and health, in the poor, oppressed wretches or slaves driven to work by threat and terror, experiencing all the rigors of humanity and severity of the elements, suffering hunger or using low viability, spoiled and repulsive food work, owing to the state of muscles, is the most common cause of exhaustion or depletion of blood and other body parts from all viability, and therefore a source of multiple diseases. The same thing happens in case of a soldier, dragged away from plough or workshop and almost always athletic; if in battle, labour, sudden marches there is no sufficient supply of matter capable of elaborating blood. This is why the miserable class of the people and the badly supplied army are most often victims of the most dangerous diseases.

643. — One can not consider the whole class of craftsmen as one because there are so many crafts, while the type of work done is so different that both the constitution and tendencies of the people involved in them must be very different. In general, there are crafts burdened with hard physical labour and little or no intellectual work; or such that fix the craftsman to one place, providing much employment to the hands and eyes and little or none to the mind; or, finally, those which, though attaching a craftsman to a single place, employ the mind, leaving few tasks to the little body. Here, I do not touch upon crafts in which the material treated by the craftsman may also influence his constitution and health. The first class of craftsmanship will evidently lead

to athletic constitution, such as farming, indeed, even with more certitude, because the craftsman's earnings are almost definite and evident. Such artisans are: blacksmiths, ironmasters, carpenters, woodworkers, wheelwrights, coopers, etc. The second class is conducive, of course, to the inactivity of the body and mind, and thus to some kind of infirmity, usually making people impassive and indifferent. Such crafts include tailoring, shoe making, weaving and all minor handicrafts done in the workshop, which should, as a matter of fact, be called women's work. This class of artisans proliferates among the common people inhabiting villages and towns, especially in countries abounding in all kinds of factories and handicrafts. Such people are weak, fearful, and equally uneducated as thick in the head; the slightest novelty astounds them greatly and makes them numb, strangely manifesting the state of mind: inactive and wicked; the slightest terror scares and distracts them, while the slightest variety lures them and delights. Artisans of the last kind are employed under the name of artists, and fall into the class of scholars, for instance painters, woodcarvers, architects, musicians, etc.

644. — Scholars, devoted to mental work and lead sedentary life, cherish only the nervous system, with the detriment of other systems and organic elaborations. Thus, equipped with stronger powers of mind they have a definite inclination to all kinds of nervous agitation, and therefore, exceptional sensitivity and an immense opportunity to exultation and zeal. On the contrary, their muscles are weak,

digestion difficult and imperfect, and other organic elaborations are quite poor. In short, they represent the purest form of the nervous constitution, which, if enclosed in decent limits, is proper and necessary to their condition. Nonetheless, if these limits of glorious mediocrity are trespassed, the learned people metamorphose into most unbearable in the society, presenting us either with bachelors of art, pompous wiseacres, full of themselves or anxious zealots and destructors of the public order. Such patterns of exuberant nervous system give us creators of the new sects, systems, exaggerated theories of all manner, which they will defend with greatest fervour. This is the source of all kinds of fanatics, both religious as well as political, ready to eradicate the rest of the human race because their, so to speak, over-inflated brains, are ready to bend all the rules. These are the most dangerous people, and if they have power at hand to defend their opinions, as we have had some terrible examples of this during the French Revolution; if they have no power at all, they close in themselves and regard the rest of the human race with a smirk of pity or with contempt, seeing in others only meagre beings, far more inferior than themselves.

645. — In the society there are also classes of sedentary people, attached to one place who, albeit, ought to be regarded otherwise than scholars, because their intellectual work and nurturing of the nervous system are far from the extent that we find in the latter. This category includes all the senior and junior office workers employed by national governments who, in most cases, closed behind the doors

of various offices, revel in sitting at desks and writing; this category includes clerks working in trade offices, and all those who run small trades and sit in their stores. Persons of this kind maintain all systems and organs in weak and insignificant activity, such that it can almost be considered complete idleness; hence their weakness, both of body and mind, deficient digestion and animal elaboration if they do not compensate inactivity in their free time with more energetic exercise of body and mind, to which they are exposed owing to their lifestyle. But if their income is sufficient to afford comfortable life, then the inactivity resulting from the kind of employment is rewarded with artificial acceleration of the rate of life thanks to spicy and plentiful meat foods, and the use of mind elevating beverages. This way of life, maintaining the digestive organs in good working order, is the foundation of sanguine constitution combined with the weaker elaboration of arterial blood, and leads to obesity. In the same category we find people whose social relationships provide a comfortable and carefree life, and predilection or taste for inactivity of body and mind; in that condition we see almost all calm and prosperous estate owners, clergy, especially from higher circles; senior officers in countries enjoying long periods of peace; wealthy artisans and artists, and physicians less caring about the state of their competence.

646. — However, what we have already said about the physical constitution of persons in the various classes of the society does not concern everyone in universality; every

circle of the society includes people who live their own way. And so, there are the rich who live modestly and humbly, not pestered by ambition, not tormented by jealousy, not tickled by vanity or lured by debauchery, not bored and outraged by inactivity; but who devote themselves to farming, hunting, arts and science. Such a constitution must, of course, differ from that we find in other wealthy people. Likewise, there are poor people who do not work, but live by the grace and benefaction of kitchens of the rich; there are scholars and artists who do not think much; government officials, judges, and members of the clergy who do not stay in one place, craftsmen who have little interest in their craft. This is why a physician who rarely deals with the whole class of people but only with *individuals*, should become familiar with habits, way of life and way of thinking of every person in particular, and if he wants to acquire comprehensive knowledge about constitution the source of the diseases which he is about to treat. But the time has come for us to start analysing their nature and causes.

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Glossary*

Allen, William (1770–1843), English scientist and pharmacist, authored in early 19th ct. a number of papers on experiments with respiration and calculation of elements ratio in air.

Animal economy (*ekonomija zwierzęca* or *gospodarstwo zwierzęce*) — physiological and biochemical management of functions in a living being.

Animalisation (wyrobienie zwierzęce czyli animalizacya) — transformation of non-living matter into a living one in animal or human organs.

Aristotele (384 BC – 322 BC), ancient Greek philosopher, known mostly for contributions to logic and philosophy, but also medicine. Among his contributions was the description of humans as animals with inclination to imitation.

Augustus, King Stanislaus *see* Poniatowski, Stanisław August.

Ballard, Jean Jacques (1776–1841), French military physician, participant of a Napoleonic war in Russia in 1812. One of the translators of *Theory of Organic Beings* to French language (1825).

Beddoes, Thomas (1760–1808), English physician and scientific writer, professor of chemistry at Oxford University and inventor of so called pneumatic medicine (treating diseases by the inhalation of different gases).

Berkeley, George (1685–1753), Irish philosopher, famous for the theory of "immaterialism" denying the existence of material substances and stating that objects are only ideas in human minds.

Berzelius, Jöns Jacob (1779–1848), Swedish chemist, considered one of the founders of modern chemistry.

* All chemical and anatomical terms have been translated into modern English, unless there a proven historical name for a given term, in such case the historical term has been used, explained in the context.

Blagden, Charles (1748–1820), British physician and scientist, renowned for experiments on how dissolved substances, like salt, affect the freezing point of water, leading to the discovery of Blagden's Law, as well as for experiments on the influence of high temperature on human body. *Experiments and Observations in an Heated Room* (1775).

Bonnet, Charles (1720–1793), Swiss naturalist and philosophical writer, author of a metaphysical system of classification of existence postulating continuity from inanimate to animate world.

Brown, John (1735–1788, also Joannis Brunonis), Scottish physician, creator of the Brunonian system of medicine (also *Brownian* doctrine) which stated that all disease was an outcome of over or under-stimulation. This system was particularly influential among practical physicians, especially in Germany.

Brownian doctrine see Brown, John.

Brukowe Wiadomości (*Wiadomości Brukowe*) — satirical journal published in 1816–1822 in Vilnius, organ of the enlightened literary-moral society called *Towarzystwo Szubrawców* [*Society of Rascals*], whose members included also professors of Vilnius University and which Jędrzej Śniadecki presided in 1819–1822.

Caloric (*cieplik*) — the caloric theory was a scientific theory in the late 18th ct., stating heat consists of an invisible and weightless substance called caloric. In the 19th ct. it was replaced by the mechanical theory of heat.

Camper, Pieter (1722–1789), Dutch physician, anatomist, physiologist, obstetrician, zoologist, anthropologist, paleontologist. He was one of the first authors to distinguish anthropology from natural history and helped establishing comparative anatomy.

Cooper, Astley Paston (1768–1841), English surgeon and anatomist, who made substantial contributions to anatomy and pathology of glands and testicles, and the pathology and surgery of hernia. He was famous for experiments of cerebral circulation in dogs.

Crawford, Adair (1748–1795), English chemist and physician, known for his book *Experiments and Observations on Animal Heat and the inflamation of combustible bodies*: *being an attempt to resolve these phaenomena into a general law of nature*. Philadelphia: Thomas Dobson, 1779, and pioneering work in calorimetric.

Dalton, John (1766–1844), English chemist ad physicist, pioneer of atomic theory of chemistry.

Darwin, Erasmus (1731–1802), English physician, inventor and poet of the Enlightenment, working on natural history. His work *Zoonomia* (*Zoonomia, or the Laws of Organic Life*. 2 Vols. London: J. Johnson, 1794–1796), foreshadowed some of the views of Lamarckism and evolution theory.

Davy, Humphry (1788–1829), English chemist and inventor, renowned for isolation of a number of substances like potassium and magnesium. End of the 18th century he conducted a series of experiments concerning respiration which challenged the existence of caloric, and published, most importantly, *Researches, Chemical and Philosophical; Chiefly Concerning Nitrous Oxide, or Dephlogisticated Nitrous Air, and Its Respiration*. Bristol: Biggs and Cottle, 1800.

Dessaix, Jean-Marie (17..–1844), French military physician, participant of a Napoleonic war in Russia in 1812. He was personally acquainted to Jędrzej Śniadecki, and was one of the translators of *Theory of Organic Beings* to French language (1825).

Dodart, Denis (1634–1707), French physician, naturalist and botanist, notable for studies of plant growth and respiration.

Dram — a unit of mass and a unit of volume in the apothecaries' system, the mass of 1/96 pounds apothecaries or 1⁄8 ounces apothecaries or exactly 3.8879346 grams.

Dziennik Wileński — Vilnius-based journal established and edited by Jędrzej Śniadecki and others in 1805–1806, 1815–1825. One of earliest Polish-language scholarly respectively popular-scientific journal, publishing articles in a broad range of disciplines.

Falloppio, Gabriele (1523–1562), Italian surgeon and anatomist, he was the first to describe the tubes leading from the ovary to the uterus, they were subsequently named the "Fallopian tubes" in his honour.

Fontana, Felice Gaspar Ferdinand (1730–1805), Italian logician and natural scientist, known for research on nerve system and brain anatomy.

Fourcroy, Antoine François comte de (1755–1809), French chemist and politician, co-author of modern chemical terminology.

Frank, (Johann Peter) John Peter (1745–1821), German physician and hygienist, professor in Göttingen, Pavia, Vilnius (1804–1808) and afterwards in Vienna universities. Author of voluminous *System einer vollständigen medicinischen Polizey* [*A Complete System of Medical Policy*]. Mannheim: C. F. Schwan, 1779–1819.

Galen of Pergamon (Galenus, Claudius Aelius; 129 – c. 200/216), Greek physician, surgeon and philosopher, working in the Roman Empire. His work influenced both Islamic and Mediaeval medicine, up until the Renaissance. Classical work of see *humorists*.

Gall, Franz Josef (1758–1828), German and Habsburg neuroanatomist, physiologist, and pioneer of cranioscopy and phrenology.

Galvani, Luigi Aloisio (1737–1798), Italian physician, physicist and biologist, discoverer of animal electricity.

Goodwyn, Edmund (1756–1829), British physician, medical writer, educated in Edinburgh and practicing in London. His book *The connexion of life with respiration*; *or*, *An experimental inquiry into the effects of submersion*, *strangulation*, *and several kinds of noxious airs*, *on living animals*: *with an account of the nature of the disease they produce*; *its distinction from death itself*; *and the most effectual means of cure*. London: T. Spilsbury, 1788, was an important contribution to experimental research on pulmonary system.

Graaf, Regnier de (1641–1673), Dutch physician and anatomist who made key discoveries in reproductive biology.

Grain (*gran*) — unit of measurement of mass, in, among others, apothecaries' system, equal to 64.79891 milligrams.

Gregory, James (1753–1821), Scottish physician, head of the School of Medicine at the University of Edinburgh and President of the Royal College of Physicians of Edinburgh.

Groddeck, (Grodek) Gottfried Ernst (1762–1825), Danzig-born classical philologist, a teacher of children of Polish-Lithuanian nobility. Since 1804 professor of Greek language and literature in Vilnius University.

Guyton, Louis-Bernard Baron de Morveau (1737–1816), French chemist and politician, credited with producing the first systematic method of chemical nomenclature.

Hales, Stephen (1677–1761), English clergyman, botanist and physiologist, the first person to measure blood pressure. In *Vegetable Staticks*. London: W. and J. Innys, 1727, he made crucial experiments on plant transpiration and chemistry of air.

Hallé, Jean Noël (1754–1822), French physician, whose most important work was concerned with hygiene and epidemiology.

Haller, Victor Albrecht von (1708–1777), Swiss biologist, famous for his studies on irritability and sensibility of muscles and nerves.

Hewson, William (1739–1774), British surgeon, anatomist and physiologist, investigating, among others, the blood and lymphatic system.

Humboldt, Alexander von (1769–1859), Prussian polymath, naturalist and explorer, whose work laid basis for among others, botanical geography.

Humorists — advocates of a medical theory, that stated that the human body is filled with four basic substances (humors), blood, yellow bile, black bile and phlegm, deficiency or abundance of which influence temperament and health of a given person. This theory is of Egyptian origin and was systematized by Greek philosophers, most importantly Hippocrates and Galen of Pergamon, remaining influential until 19th ct.

Hunter, William (1718–1783), Scottish anatomist and physician. He was a leading teacher of anatomy, and the outstanding obstetrician of his day. One of his contributions was *On the Digestion of the Stomach after Death* in *Philosophical Transactions* 62 (1772).

Jundziłł, Stanisław Bonifacy (1761–1847), Polish-Lithuanian botanist and educator, from 1802 professor of botany and zoology at the Vilnius University.

Jurin, James (1684–1750), English scientist and physician, who investigated capillary system and the properties of blood.

Iuvenālis, Decimus Iūnius (Juvenalis) (1st ct. AD – 2nd ct. AD), Roman poet, famous for satires, considered in secondary literature as “angry satirist.”

Kochanowski, Jan (1530–1584), Polish Renaissance poet, whose works were crucial for the development of Polish literary language.

Lavoisier, Antoine Laurent, de (1743–1794), French chemist, and politician, who recognized oxygen and hydrogen, was one of the reformer of chemical nomenclature and formulated the law of conservation of mass. He was particularly influential in combatting the phlogiston theory.

Leeuwenhoek, Antonie Philips, van (1632–1723), Dutch entrepreneur, scientist, pioneer microscopist and microbiologist.

Linnings, John (1708–1760), medical practitioner from Charleston, South Carolina, working on yellow fever, giving one of early detailed description of yellow fever's symptoms and its course. His work on transpiration was popularized by his colleague Lionel Chalmers' *Essay on Fevers*: *more particularly those of the common continued and inflammatory sorts*: *wherein a new and successful method is proposed for removing them speedily*. Charleston: Robert Wells, 1767, translated into German in 1773.

Linnaeus, Carl (Carl von Linné, 1707–1778), Swedish botanist, physician, and zoologist, famous for systemization of modern system of naming organisms.

Lycurgus (7th ct. BC), a legendary lawgiver of Sparta, who promoted equality, military fitness, and austerity.

Malpighi, Marcello (1628–1694), Italian biologist and physician, pioneer of microscopy. In *De Viscerum structura exercitatio anatomica*, London: Jo. Martyn 1659, he presented the anatomy of a brain and regarded this organ as a gland.

Mangili, Giuseppe (1767–1829), Italian naturalist, taught in Firenze and, as a successor to Spallanzani, at the University of Pavia (since 1799); published studies on worms and molluscs and observations on hibernating animals.

Mascagni, Paolo (1755–1815), Italian physician, researcher of human anatomy, author of the first complete description of the lymphatic system.

Mickiewicz, Adam (1798–1855), Polish poet, publicist and political activist, considered as one of greatest poets of Polish language.

Midas, a legendary Phrygian king who is given the power of turning everything he touches to gold.

Mohammed (c. 570–632), founder of Islam. By the followers of Islam he is considered a prophet and messenger of God.

Monro, Alexander (secundus, 1733–1817), Scottish anatomist, famous for experiments and observations on brain and nervous system.

Morgagni, Giovanni Battista (1682–1771), Italian anatomist, regarded as the father of modern anatomical pathology, famously active as Professor of anatomy at the Padua University.

Moritz, Joseph, von (....–....), physician in Telsch (now Telšiai in Lithuania) and personal physician of several prominent noblemen. Translator of *Theory of Organic Beings* into German (1810).

Neubig, Andreas (1780–1861), gymnasium professor in Bayreuth and Hof in Bavaria. Translator of *Theory of Organic Beings* into German (1821).

Newton, Isaac (1642–1726), famous mathematician, natural philosopher and theologist. His *Philosophiæ Naturalis Principia Mathematica*. London: Josephi Streater, 1687, is considered one of key books in the history of physics.

Pamiętnik Lekarski Wileński — Vilnius-based medical journal of Vilnius Medical Society, published in 1818–1821, 1822–1824. One of earliest Polish-language medical journals. Jędrzej Śniadecki was one of the founders of the journal.

Pecquet, Jean (1622–1674), French scientist, made the important discovery of the course of the lacteal vessels, including the *receptaculum chyli*, or reservoir of Pecquet.

Pepys, William Halsedine (1775–1856), English scientist and inventor of scientific instruments, together with William *see* Allen investigated the phenomena of respiration.

Poniatowski, Stanisław August (Stanisław II Augustus, 1732–1798), the last King of Poland, Grand Duke of Lithuania and the last monarch of the united Polish-Lithuanian Commonwealth (1764–1795), known as great patron of the arts and sciences.

Priestley, Joseph (1733–1804), English clergyman, natural philosopher, chemist, first one to suggest a connection between air and blood, still in the tradition of phlogiston theory.

Prunelle, Victor-Gabriel (1777–1853), French physician and politician, theoretician of animal hibernation.

Réaumur, René Antoine Ferchault de (1683–1757), French writer and entomologist, who introduced the Réaumur temperature scale. 32° Reamour equals 40° Celsius.

Ritter, Johann Wilhelm (1776–1810), Silesia-born chemist and philosopher, early experimenter in the tradition of *Naturphilosophie*.

Robinson, Bryan (1680–1754), Irish physician, academic and writer, known for work on plants and *Dissertation on the Food and Discharges of Human Bodies*. Dublin: S. Powell, 1747.

Ruysch, Frederik (1638–1731), Dutch botanist and anatomist, pioneer of anatomical preservation. He became famous for his proof of valves in the lymphatic system.

Rye, George (ar. 1680–1735), Irish chemist, living and experimenting in Cork, famous for work on human perspiration entitled *Medicina statica Hibernica*; *or, statical experiments to examine and discover the insensible perspiration of a human body in the South of Ireland*, *made for one year and some months*, Dublin: Smith, 1734.

Sanctorio Sanctorius (also Santorio Santorio, 1561–1636), Venetian physiologist and physician, pioneer of the quantitative approach in medicine.

Séguin or Segouin, Armand Jean François (1767–1835), French chemist and physiologist, Together with Lavoisier experimented on animal respiration.

Senebier, Jean (1742–1809), Swiss pastor and naturalist, remembered for providing extensive evidence of photosynthesis.

Schelling, Friedrich Wilhelm Joseph (1775–1854), German idealist philosopher, developed the so called Naturphilosophie, a romanticist approach to understand the totality of nature.

Śniadecki, Jan (1756–1830), Polish-Lithuanian astronomer, mathematician, theoretician of language, brother of Jędrzej.

Solidists — advocates of a medical theory that stated that diseases were caused by damages to the solid parts of the body.

Sömmerring, Samuel Thomas von (1755–1830), physician and anatomist born in Thorn (Royal Prussia), working in Kassel, Mainz and later Frankfurt, wrote a pivotal study of cranial nerves and brain anatomy.

Spallanzani, Lazzaro (1729–1799), Italian biologist and physiologist, professor at University of Pavia. He worked on a variety of topics from theory of microbes to animal reproduction.

Stanislaus Augustus *see* Poniatowski, Stanisław August.

Torre, Giovanni Maria della (1710/1713–1782), Italian physicist and naturalist, royal librarian in Sicily. His improved microscopic observation techniques allowed manifold new discoveries in his epoch.

Universal or *total organic power* (*siła organiczna powszechna lub całkowita*) — according to Sniadecki "organizing power ought to be considered in many ways — one of its aspects is impacting the matter in general, and in that regard it may be called universal or total organic power."

Vauquelin, Louis Nicolas (1763–1829), French pharmacist and chemist, known mostly for analytical works and experiments with birds' excrements.

Viable matter, viability (*material odżywna*, *odżywność*) — term refers not only to nourishment in the sense of nutritiveness of food, an apparently obvious association in contemporary Polish, but also to such characteristics of substances and phenomena (such as the sun, the air) which promote and sustain life.

Virgil or Publius Vergilius Maro (70 BC – 19 BC), ancient Roman poet of the Augustan period.

Volta, Alessandro Giuseppe (1745–1827), Italian physicist, pioneer in research on electricity and power. Since 1779 professor of experimental physics at Pavia University.

Wintringham, Clifton (1689–1748), English physician active mostly in York, author of *An enquiry into the exility of the vessels in a human body: wherein animal identity is explained, and shewn incommunicable to any individual throughout the whole species*. London: Thomas Osborne, 1743.

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