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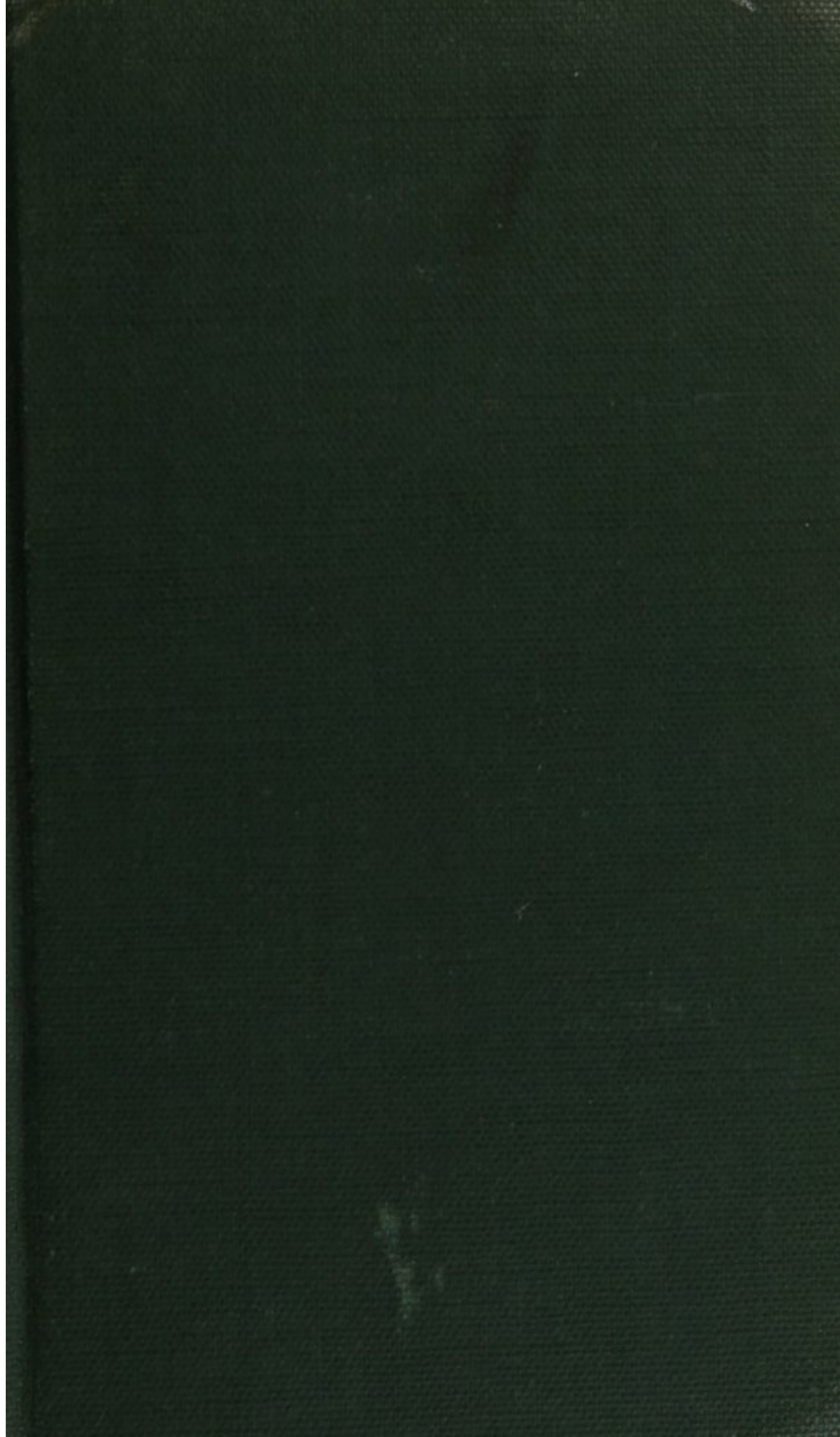
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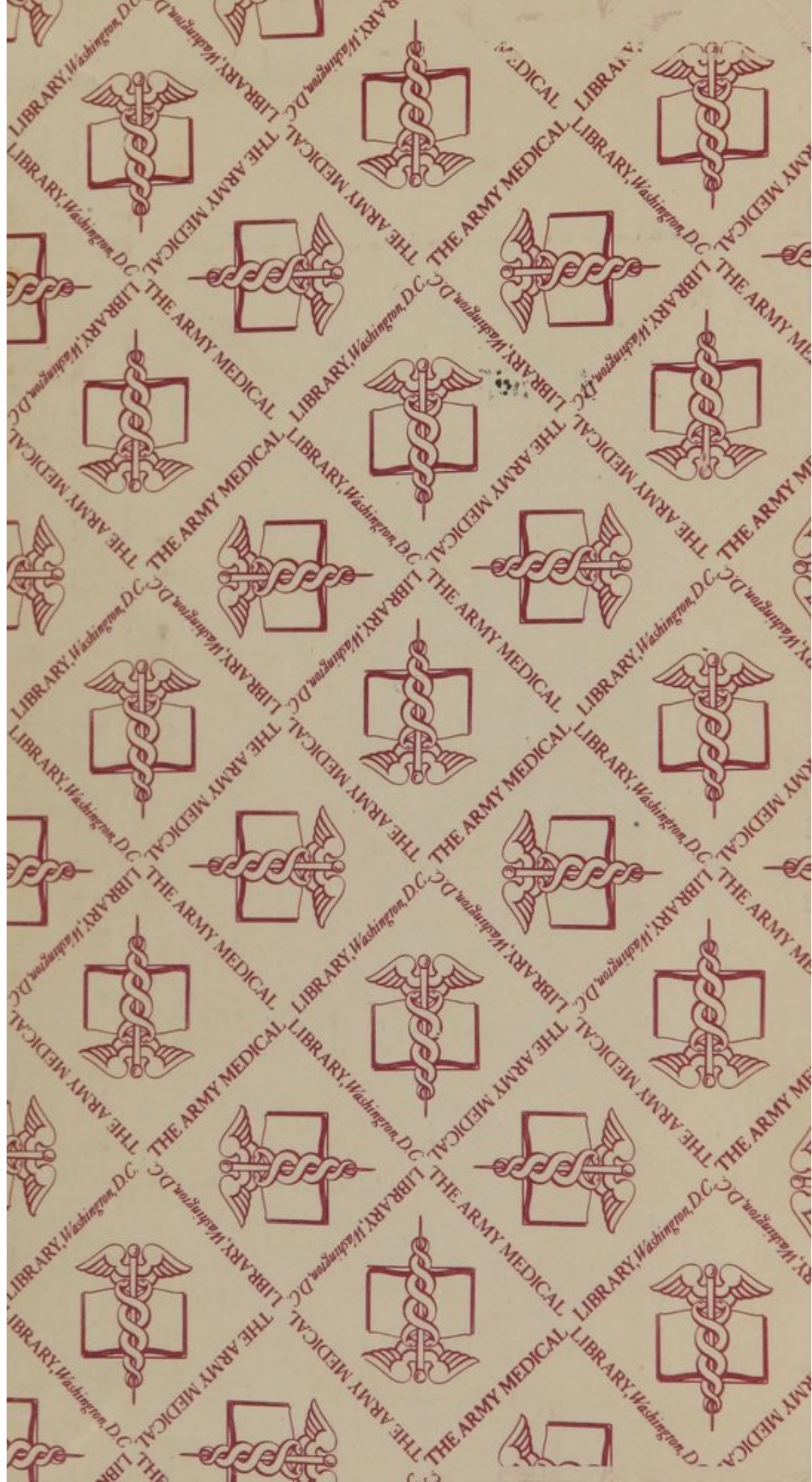
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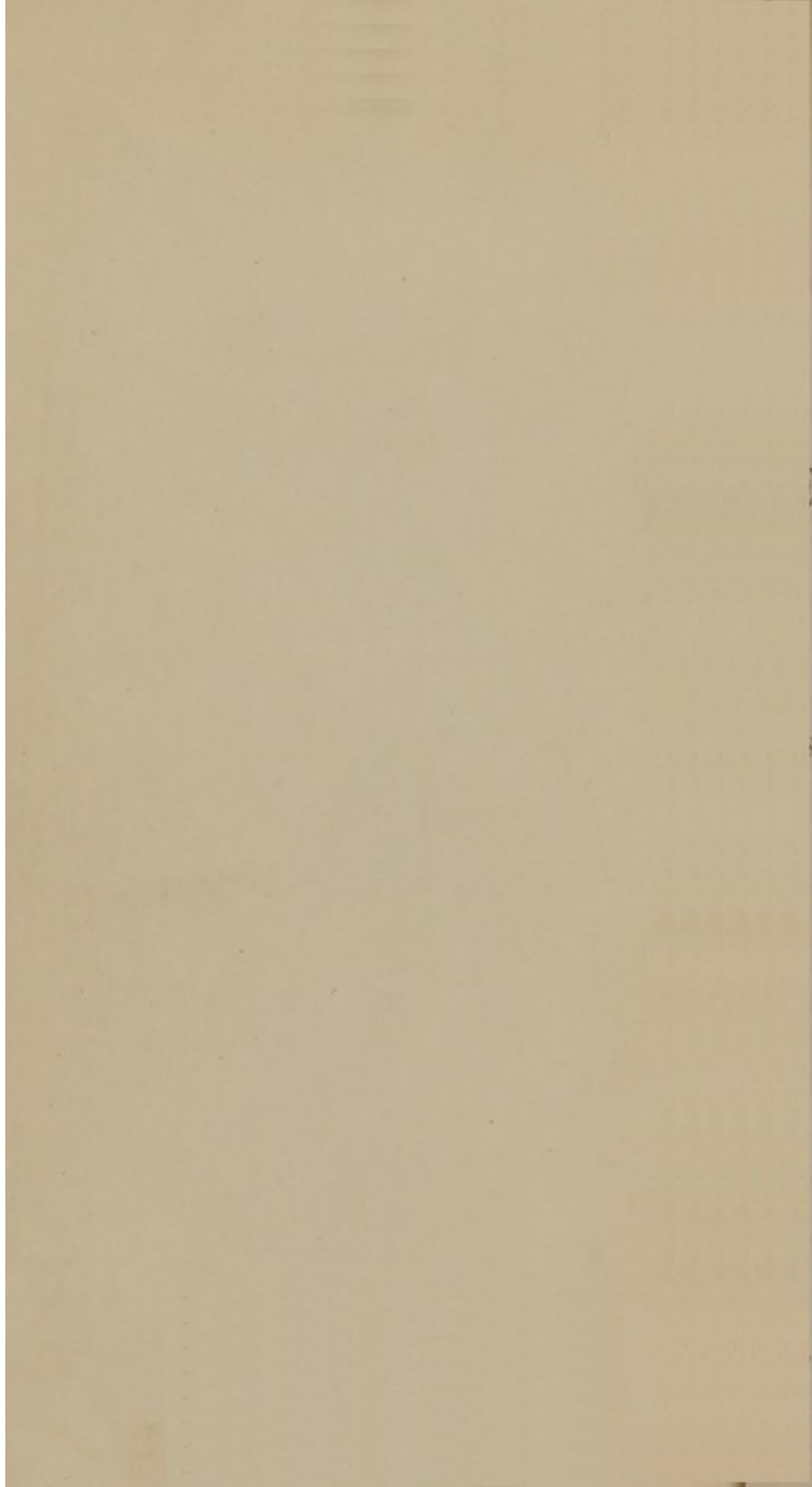
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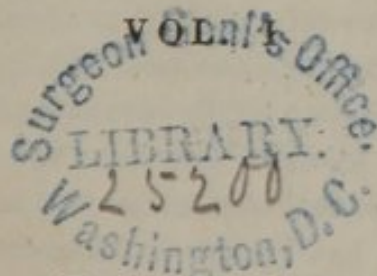


LECTURES
ON THE
SCIENCE OF HUMAN LIFE.

BY
SYLVESTER GRAHAM.

Know thyself.

IN TWO VOLUMES.



BOSTON:
MARSH, CAPEN, LYON AND WEBB.
1839.

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P R E F A C E .

THE work which I now present to the public in a printed form, is the result of my observations, reflections, inquiries, investigations and researches for more than forty years; nearly a fourth part of which time, has been exclusively devoted to it with an assiduity which has almost wholly sacrificed my social enjoyments of life, and taxed my mind and body to a degree which has greatly impaired the vigor of my health, and probably in no small measure abbreviated the period of my earthly existence. And yet I am very far from being satisfied with what I have done. I feel that if I could have ten years more of health and opportunity, I could greatly perfect the labors of the past ten years. In regard to the great principles which I have advanced, and all the practical bearings of those principles, I feel the most entire confidence, and have wish for longer time to satisfy myself of their correctness; but I think that with more time and labor, I could, in many respects, improve the method in which I have presented them, and give more strength to the argument and force to the illustration.

My undertaking has, from the commencement of my career as a public lecturer, been a most difficult, as well as a most arduous one. I have endeavored, for nearly ten years past, by oral instruction, to bring to the comprehension and understanding of the popular and unlearned mind, one of the most abstruse and complicated subjects, within the range of the natural sciences. To do this with any degree of success, and to excite and keep up sufficient interest in the minds of those I wished to benefit, to make them willing to attend to such instructions, I have been compelled to exercise all the versatility of power and resource that I have been able to command. This of necessity, has obliged me to depart widely from that conciseness and simplicity of method which properly belong to scientific reasoning; and to be at times diffuse in manner, and redundant in illustration. And now, I am fully conscious that if learned men, of severely disciplined minds, do my work the honor to peruse it, they will find occasion to complain of the same evils in the printed form of my lectures. And my apology is that, I have

still in view the same great class of people. If my design had been to prepare a work for the scientific reader only, I should have written it in very different style and method; but my desire is to carry my instruction into every family, and to be understood by every individual of ordinary capacities. And if I have not erred in judgment, I have not retained more diffuseness of style, nor copiousness of illustration, nor indulged more in repetition than the best adaptation of such a work to the popular mind requires.—My great object is to have the principles which I inculcate, clearly understood. And minds wholly unaccustomed to scientific investigations cannot readily apprehend the general principles of such a complicated subject without a fulness of explanation and illustration, approaching to redundancy.

But it may be asked, if I intend my work for the unlearned reader, why I have not wholly refrained from the use of the technical terms of scientific language, and expressed myself in terms that every one can readily understand?—This is a difficulty which I have fully appreciated; and at first, endeavored to avoid:—but I soon found that it would compel me to use great circumlocution and tedious repetition: and on further reflection, I was satisfied that it is best even for the unlearned reader, that the technical terms should be retained, and so explained that he can understand them. Thus, when describing the nervous system, I at first gave a particular description of the *trisplanchnic* nerve, (§ 220.) without giving its scientific name; and in the course of one or two pages I was obliged to speak of that nerve again, and found myself under the necessity of repeating the whole description, for want of a name; and then the thought occurred to me, that however well my readers might become acquainted with the anatomy of the nervous system by studying my book, yet if they should take up any other work, in which the *trisplanchnic* nerve, or any other part of the human system was spoken of in the ordinary language of science, they would not be able to understand what parts were intended, any better than they would if they had never seen a description of the parts. If by any means therefore, we can make the unlearned reader acquainted with the meaning of these terms, we greatly benefit him; for we thereby, as it were, teach him the alphabet of science, and greatly increase and enrich the furniture of his mind; which always enlarges his understanding and facilitates his attainments in knowledge. With this conviction, I have retained the technical terms of science pertaining to my subject, and have endeavored to enable every reader to understand them, by explanations in the text, and by continual references. Thus in § 313. I explain the meaning of the terms, *organ*, *tissue*, *viscera*, &c., and afterwards when I use

these terms, I frequently refer back to this section. By these means, and by the help of a key or dictionary, attached to the second volume, containing all these terms with a full explanation of them, I hope every reader will soon be able to come to a clear and ready understanding of them.

I have endeavored, as far as I could in such a work as this, to follow the plan of Euclid's Elements of Geometry:—that is, by referring continually to previously ascertained principles, or established facts and conclusions, whenever they are involved or illustrated or alluded to in any process of reasoning, I have made one part explain and corroborate another, and by this means, I have put it in the power of every individual of suitable age and ordinary intelligence, by a proper degree of application, to attain to a very clear and full understanding of my work, not only in its particular, practical bearings, but in its general system of principles as a science.—I hardly need remark however, that a work of this kind, cannot be read as an amusing novel, nor as an entertaining narrative or history; but it must be studied, attentively, and perhaps at first, with considerable labor, or few will be the wiser or the better for the time they devote to it. It is not possible that such a work as this, which has required the intense mental labor of many years to produce it, can be fully comprehended, from a single hasty perusal, even by a well disciplined, and much improved mind; and still less, by minds destitute of scientific education and habits of close and connected thinking.

It is perhaps, proper that I should explain in this place, a single point, in relation to my general subject, concerning which, there appears to have been much popular error of opinion. The idea has very frequently been advanced, that my whole theory in relation to human diet, has been founded on the opinions of Pythagoras and others who have taught that man ought to subsist entirely on vegetable food. But nothing is farther from truth than this. I had, it is true, read of Pythagoras and others who subsisted on vegetable food; but the subject had never made the slightest impression on my mind; and nothing was more remote from my thoughts, when I commenced my labors as a public lecturer, than the idea that man ought to confine himself wholly to vegetable food.—From the natural turn of my mind, I had from childhood, been given very much to observations and reflections and inquiries concerning the anatomy and physiology of the human body; (§ 553.) but without any other object in view than the gratification of my thirst for knowledge, and particularly, knowledge of first principles, and the relation of cause and effect. Being very early in life convinced by observation, of the mischievous effects of intoxicating drinks, I began while yet a lad to

remonstrate with my companions and others against the use of them. This led me not only to apply what physiological knowledge I possessed, but also, to improve that knowledge continually, in order to convince others of the correctness of my opinions. In June, 1830, I was prevailed on to become the general agent of the Pennsylvania State Society, for the suppression of the use of Ardent Spirit. But with my mental constitution, it was impossible for me, to be satisfied with mere declamation against drunkenness. I wished to give my hearers the reasons why they should not use intoxicating drinks. This led me to apply my mind more exclusively and diligently than ever to the study of human physiology, and finally to animal and vegetable physiology in general: but without proposing to myself any conclusion to which I would arrive; or even dreaming whither my pursuits would lead me. I was an honest and sincere inquirer after truth; and willing to receive its teachings and follow where it led without waiting to see how it would affect my interests or my habits. In this manner I was led on, from step to step, in my purely physiological investigations, and was as much surprised at the discoveries which I made, as any have been at the conclusions to which I arrived.

Having served the Pennsylvania Temperance Society about six months I resigned my agency, without any idea of continuing my labors as a public lecturer. Soon after my resignation however, I was persuaded to give a course of my lectures on human physiology, diet and general regimen, at the Franklin Institute in Philadelphia; and before I had completed this course, I received an urgent invitation from New York, to visit that city, and deliver my lectures there. In New York, I received pressing invitations from every quarter; and thus, most unexpectedly to me, have I been kept industriously employed in this great field of labor, till the present time:—and my public lecturing, though extremely arduous, has, by no means been the severest part of my labor. Almost every hour of my life, during the whole time not necessarily appropriated to the wants of my nature—including many hours that others devote to sleep—I have employed in the most intense mental application to the great subject which has occupied my attention.

My theory in relation to the diet of man therefore, has neither been founded on, nor suggested by the opinions of others who have taught that vegetable food is the proper aliment of the human species; but my eye has been continually fixed on the living body,—observing its vital phenomena, studying its vital properties and powers, and ascertaining its physiological laws: and wholly without the consciousness that any human being had ever advanced the idea that man should confine him-

self to vegetable food;—and wholly without the purpose in my mind, of establishing such a position! But I was unexpectedly and irresistibly brought to such a conclusion, purely by my physiological investigations. Yet when I had thus arrived at this conclusion, and began to look about me, and survey the history of man, I soon discerned that there were not wanting facts, in the experience of the human family, to corroborate the conclusion to which I had been brought by my physiological investigations:—and when I came to advance my opinions on the subject, in public, immediately, on every hand, statements, and facts and testimonies began to flow in upon me in abundance. Every one who heard me and who had ever read or heard of any thing which corresponded with my views, kindly communicated it to me. In this manner, I have come in possession of nearly all the facts and authorities which I have employed in the illustration or corroboration of my principles; but in no case, have the principles been drawn from these facts and authorities. And it is but just that I should add, that many of the authors which I have cited, I have not read, but have been indebted to the kindness of friends, who have read them for me, and furnished me with such extracts, as they thought would be serviceable to me. In short, I must frankly acknowledge that I have had much less to do with books than with living bodies, in all my physiological investigations. I shall not therefore be surprised if men of general reading find that many opinions which I have advanced as peculiar to myself, have been advanced by others, with whom I am unacquainted:—for my mind has ever been much more given to observation and reflection than to reading, and hence my knowledge of books is very limited.

On the subject of anatomy, my attention has been more directed to the nervous system, than to other parts of the body; and therefore, though I have attended much to dissection and general anatomy, yet in preparing my work for the press, I have frequently felt the want of a more familiar acquaintance with the minute anatomy of particular parts, which I had before regarded as of comparatively little importance to physiology, but which I considered necessary in my printed work in order to render it complete. I am therefore, not entirely certain of being perfectly accurate in every minute point of anatomy, but I trust that I have in no case made any great mistake; and I am confident that I have made no mistake on any important point.

In regard to Phrenology, I have perhaps said enough in the body of my work, (§ 532. *et seq.*) but I wish the zealous advocates of that theory, distinctly to understand that I entertain no hostile feelings towards it. I have aimed not to misrepresent it; and if I have fallen

into any mistakes in regard to it, I shall be glad to be corrected; and am ready to embrace it as fully and as warmly as any of them, when I can be as fully convinced of its truth and importance as many of them appear to be. But at present, I must honestly confess I have doubts on some points; albeit I am not far from a full conviction that, in the true science of intellectual and moral physiology, the brain is to be regarded as an assemblage of special organs, according to the views of Dr. Gall. (§ 601. 639. 1236.)

Concerning the natural element or elements of matter, (§ 47. *et seq.*) its properties and laws, and the production of the various forms of material things, I suppose I shall be considered sufficiently visionary, by some; but it will be seen that I am not wholly alone in the speculation; although I supposed myself to be alone in it, for several years after I embraced the notion, and have, from time to time, been not a little gratified to find myself sustained in it, by such high authorities as I have since met with. (§ 74. *et seq.*) But, whatever may be true in regard to the number of the natural elements, the great physiological and psychological principles which I have advanced, (§ 522. *et seq.*) are, I am confident, irrefragably true: and these are all that I wish to insist on, in relation to the nature and properties of matter. (§ 105. 106.)

In presenting my lectures to the public, at this time, in a printed form, I feel it my right and duty to remark that, it would be very unjust in the public to date their existence from this period.—It must be remembered that I have been repeating these lectures in public for nearly ten years.—When I began these public labors, the subject of human physiology,—so far as I am informed, had not been named nor thought of, by any other person, as a matter of popular knowledge and general education: but since that time, it has been continually becoming more and more a subject of public interest:—and now, physiology and physical education are common topics of conversation, in almost every circle.—I do not mean to imply however that my labors alone have produced all this effect.—Since I have been in the field, several works have appeared both in England and America which have embraced different portions of the same great subject.—These have undoubtedly had much influence on the public, and contributed to produce the present state of things.—There is one work, however, which I believe, was published, in England or Scotland, before I commenced my public lectures, and which has probably done more than any other one, to excite a popular interest on the subject of physical education:—but I speak of it only from report, as I have never read it, and know nothing of its merits, except from the testimony of others. I allude to the

“Constitution of Man” by Mr. George Combe. The first time I ever heard of this work was in the summer of 1833: when I was accused of having borrowed my views from it. This induced me to form a resolution never to look at it till my own lectures had passed through the press. I have adhered to that resolution, and can therefore only say, if there are views in my lectures corresponding with those advanced by Mr. Combe in that or any other work, we have both hit on them without any indebtedness to each other.—Indeed, I have seen but few of the works which have appeared since I commenced my public labors, in relation to the general subject embraced by my lectures, and those which I have seen, I have been able only to glance at hastily.—Abercrombie’s writings I am wholly unacquainted with:—and in fact, it is nearly twenty years since I have read any work on intellectual and moral philosophy.

While therefore, I have gathered all along my course such facts and testimonies, in illustration and corroboration of my views, as my numerous friends have kindly placed within my reach, or selected for me, yet all the principles and the main body of my lectures, which now first appear in print, have a just claim to at least as early a date as 1832.

In the progress of my labors however, I have been much indebted to many professional and scientific gentlemen, of our own country, for numerous advantages and facilities which have been greatly serviceable to me; and were it proper, I would gladly name several gentlemen of the Medical Profession in Philadelphia, New York, Boston and other places, whose many civilities and favors deserve and receive my sincere acknowledgments, in this place. It has ever been a cause of deep regret to me, that there has been so extensive a misunderstanding on the part of many members of the Medical Profession, in regard to the character and tendency of my labors. And now I can only assure them that I entertain the highest respect for the Profession.—It is certain that without a well-educated Medical Profession, of high moral tone, society cannot prosper; and it is equally certain that, such a Profession will be most accurately estimated where society is most intelligent in regard to the proper qualifications of such a Profession, and therefore, the most certain means of destroying every species of medical empiricism and imposture, and of securing the highest confidence in a responsible Profession, is to enlighten the people in the knowledge of the laws of life and health.

In all my public labors I have carried with me a deep and solemn sense of responsibility, which has at times almost overwhelmed me! most conscientiously have I desired, and sought to find out the truth,

for the truth's sake, and to promulgate it for the good of man.—With that same deep and solemn sense of responsibility, and that same conscientious purpose of soul, I now present this printed work to the public. If I believed it to contain any mischievous error, God knows I would not send it abroad, to do evil in the world. Yet I am but a human being, and with all my sincerity of purpose, and untiring diligence to ascertain the truth, it is possible I may have fallen into some mistakes; and this consideration has led me to refuse to have the first edition of this work stereotyped, because I wished to have the opportunity to correct any errors that might be pointed out: and therefore, I now sincerely and earnestly entreat all medical gentlemen and others, for the sake of truth and humanity, to examine this work critically, and to expose every error they may discover in it. If they attack it with ridicule and vituperation, I shall have no confidence in their honesty, but will nevertheless endeavor to be benefited even by their abuse:—but if, in a manner which evinces an honest disposition to serve the cause of truth and humanity, they point out its errors or its blemishes, I shall gladly and gratefully receive their corrections, and apply them to the improvement of my work.

Many good people have entertained the idea that the dietetic doctrines of my lectures, are contrary to the Sacred Scriptures; and that the promulgation of them is unfriendly to religion. The fears and prejudices of such people, however ill founded, are to be regarded with respect, seeing that they spring from those elements in the mental and moral constitution of human nature, which, when properly exercised, lead to the just regulations of society, and on which the correctness and stability of all good institutions among men, depend. I wish therefore, to assure such people and all others, that I have not been unmindful of these things; but have thoroughly examined them. It was not suitable that I should include the results of my investigations on these points in such a work as this; but I have another work nearly prepared for the press, in which I have entered extensively and fully into a careful examination of every point of relation between my lectures and the Holy Scriptures. It is my purpose to present that work to the public as soon as possible: and I trust it will wholly satisfy every honest and conscientious mind, that there is the most entire harmony between the Sacred Scriptures, and the dietetic and other principles taught in this work.

Northampton, February, 1839.

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GRAHAM'S LECTURES.

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§ 1. MAN is the soul of the world—the intellectual and moral sensorium of nature.

He is not, indeed, the creating Cause of things, nor is he the efficient Energy by which the various operations of nature are carried on.—He does not sustain the sun in his bright sphere, nor cause the light and heat to come down upon us as an all-pervading spirit.—He does not wheel the planets in their eternal rounds,—nor roll the earth upon her axis,—nor urge the moon along her silent way.—Nor does he heave the ocean's tides, nor pour the streams and rivers from their fountains, nor direct their currents in their winding paths.—He does not

clothe the earth with vegetation, nor embellish it with verdure, and the various hues and tints and forms of beauty,—nor fill it with rich fragrance and delicious fruits.—Nor does he quicken this magnificent theatre of being with the numberless forms and modes of animal existence.—Yet, but for man, to what great intellectual and moral end would all these things exist?

§ 2. The grazing ox might crop the grass, and, for all the purposes of his nature, instinctively discriminate the odors of the earth, and slake his thirst in the clear stream; and, when the summer's heat became oppressive to him, he might seek the cool shade of the forest; and, in his ruminating moments, he might raise his head, and on his uninquiring eye the sun or moon, or the far distant star, might pour its light: but neither the herbage nor the fragrance nor the varied hues of the vegetable kingdom, nor the beautiful freshness of the morning, nor the noontide splendor, nor the soothing silence of the summer twilight, nor the magnificence of the nocturnal firmament, nor aught of creation's loveliness or sublimity, would awaken in him the deep musing of philosophic thought, or moral feeling, or reflection.

§ 3. Not so with man! He opens his percipient faculties on the surrounding world, and light with its variety of hues and visual properties of external things, and the various odors of the earth, and all harmonious and discordant sounds, and the qualities of taste and touch, rush in and make their impressions upon his intellectual and moral sensibilities, and awaken there the elements and energies of mind and moral feeling. And thus all substances and qualities and things surrounding man become to him the great alphabet of knowledge. The numerous properties which inform his senses, seem to come in as with intelligence to inspire his intellectual operations

and to constitute a part of his own mind;—and he throws out his thoughts and feelings over all things and associates and sympathizes with them, till he becomes, as it were, a part of them, and they of him, and until he learns to arrange these various elements into systems and elaborates from them the profound truths and principles of science!

§ 4. The beautiful, the harmonious, the sublime, associated with external things, are but the inward sentiments of his own soul, awakened by those things and breathed out upon them, till they become, to his imagination and his feelings, invested as with an intelligent and sympathizing spirit, which holds communion with him in his various moods of mirth and melancholy and poetic musing and solemn meditation.

§ 5. The mountains and the valleys and the streams,—the deep forests and the spreading lawns,—the ocean's foaming beach, the craggy cliff, the thundering cataract, and all other things in nature, are endowed by him with their peculiar genii, and become, as it were, the talismanic keys which awaken their appropriate tones and melodies and strains within his breast. And thus he grows in knowledge and wisdom, and in moral character, and erects an immortality of thought; and makes all material substances and forms and qualities inservient to mind.

§ 6. He lifts his eye to the heavens and beholds the sun and moon and myriads of stars, whose light descends upon him like an informing spirit; and he diligently contemplates them till he learns to weigh them in his balance and measure their dimensions and their far-sweeping orbits; and ascertains their laws and their relations;—and finds the universe to be a vast fraternity of material forms,—and *feels* himself to be the percipient and intelligent centre of material things,—gathering their

influences and converting them to mind, which he exerts upon them, and by which he investigates their nature, qualities, laws, relations, purposes and ultimate designs.

§ 7. Thus man becomes a part of the vast world in which he lives, and every thing becomes a part of him; and hence it may with propriety be said that man is the soul of the world.—Nor is he only thus intellectually and morally associated with material things:—his wonderfully constructed body,—the organic tenement and engine of his mind, partakes in its elements of their common nature, and is subject to those common laws of matter which bind all forms together in inseparable relations.

§ 8. Whatever, therefore, may be the interest connected with material things, man is the centre of that interest;—and consequently man, in his nature and faculties, and capabilities and condition, and in his relations to the world in which he exists, is one of the most interesting and important subjects which the human mind has power and compass to investigate.

§ 9. But it is a profound and complicated subject. An attempt to study living man either as a subject of intellectual, moral, religious, political, physiological or pathological science, singly, without a just regard to his peculiar nature and constitution and condition,—the laws of relation under which he exists,—the reciprocities and mutual dependencies of mind and body, and the various influences which act upon him, as a material, organic, animal, intellectual and moral being, would almost necessarily result in error. And for this very reason the world has ever been filled with controversies and disputes concerning man as a subject of intellectual, moral, religious and political philosophy. Volumes without number have been written on these topics, of a strange mixture

of truth and error, mainly because the investigations and discussions have been conducted on partial and improper grounds. Nor have they who have studied man as a subject of natural history or of physiology and pathology wholly avoided the same sources of error and absurdity.

§ 10. If we would know the true philosophy of the human mind, it is not enough that we, as metaphysicians, study man's intellectual faculties and capacities and laws; but we must ascertain how far the mind is connected with the body,—to what extent it is affected by the conditions of the body; and then, again, on what depend those conditions of the body which affect the mind. In order to this, the body itself must be understood in its animal and organic nature, and its physical and vital properties and laws,—in its physiological actions and pathological affections. And this investigation will disclose to us a multitude of relations between human organic life, and the animal, vegetable and inorganic world around us;—relations which not only greatly affect the body, but, in the present state of being, modify mind and morals and religion to an extent which cannot safely be disregarded.

§ 11. So likewise, if we would correctly understand the science of physiology or pathology, we must take into view, and thoroughly investigate, the whole nature and condition and relations of man.—He who treats of the functions of the human organs, and the diseases of the human body, without fully and accurately considering the modifying influences of the mind, and of the various physical and moral circumstances acting on the healthy and on the morbid sensibilities and sympathies of the system, may indeed form a theory which will have its day of popular acceptance; but fortunate without a parallel will it be, if it does not, sooner or later, prove to

possess sufficient error to sink it into utter disrepute, if not into total oblivion.

§ 12. There is probably no subject which the mind of man has ever contemplated, concerning which more extensive and enormous error prevails, than in regard to human life and health and disease; and yet nearly every person seems to think that there is a kind of intuitive knowledge possessed by all, which enables each one to understand his own constitution and what is good for him, better than another can teach him.

In relation to almost every thing else in nature, mankind are willing to acknowledge that there are fixed principles and permanent laws and established order and system.

§ 13. If we speak of the science of astronomy, and assert that God has constructed the planetary system upon fixed principles and arranged the several bodies according to precise laws,—that the relative size, weight, distance, velocity, and every thing else in regard to the whole planetary system, are regulated and governed by the most exact and permanent laws,—every enlightened christian and theist will readily admit the truth of the assertion.

Or if we affirm that, in the creation of our globe, God ordained all things according to fixed principles, and that he has established unchanging laws which govern it in every respect, our affirmation will be promptly acceded to. Or if we speak of the science of chemistry, and declare that all the molecular combinations and arrangements of matter are according to fixed laws, and that these laws always govern every chemical action and result with the utmost precision, here again the truth of our declaration will be acknowledged. If also, we assert that God has constructed every mineral according to fixed principles—that the formation of every crystal is governed by

established laws, this too will be admitted. If we proceed yet farther, and affirm that, in the vegetable kingdom, from the smallest thing that has an individual existence, to the largest tree, all are constituted according to fixed laws;—that the life, growth, health, and every thing belonging to the nature and properties and powers of the vegetable, are governed by the permanent laws which the Creator has established and continually sustains,—the truth of what we affirm will still be unhesitatingly allowed. And finally, if ascending in the scale of creation, we advance to the animal kingdom, and assert that God has created every animal, and established all its properties and powers upon fixed principles; that even in the formation of the bones and muscles and nerves, and all the organs of the human body, with their mysterious and wonderful endowments—law and order and adaptation to special purposes and ends, prevail and govern every thing,—even here the truth of what we predicate will be admitted.

§ 14. Thus, from the nice adjustments and balancing of revolving worlds, to the structure and operation of the organs of the smallest insect, and the simplest vegetable—and even to the arrangement of the particles of matter in the formation of minerals; and all the combinations of the elements of nature by which the various forms and properties of matter are produced;—throughout the whole immensity of created things—mankind will readily admit that an intelligent and wise and benevolent Creator has established law; and that by virtue of the laws which he has established and continues to sustain, the forms and properties and powers of all material things are what they are.—All, except the atheist, will frankly acknowledge that it is befitting a God of infinite intelligence and wisdom and goodness, that all the works of his hands should be established in order and harmonious system, and gov-

erned by precise and unchanging laws.—And even he who denies the existence of a God, is forward to confess that eternal and unvarying laws reign in and over every thing; and that, by the energy of those laws of nature, all the forms and conditions of matter were produced, and are preserved.—Yet, strange to tell! when all these acknowledgments are made concerning the laws which govern the material universe and all material forms,—if we turn to the higher order of Gods works, in which he has associated with organized matter, in human nature, organic vitality and animal consciousness, and sensibility and voluntary motion and intellectual and moral powers, and affirm that human life and health, and thought and feeling are governed by laws as precise and fixed and immutable as those which hold the planets in their orbits, and cause all portions of each globe, to press towards its centre, and point the trembling needle to the pole, and govern all the molecular aggregations and combinations and arrangements of matter in the inorganic and organic world,—mankind will, almost universally, without a pause for thought, deny the truth of the affirmation, and contend that human life and health and disease are matters of entire uncertainty, governed by no laws, and subject only to the arbitrary control of God; or the blind necessity of fate; or the utter contingency of accident. They do not believe that there are any fixed laws of life, by the proper observance of which, man can, with any certainty, avoid disease and preserve health, and prolong his bodily existence;—and they are confident that the experience of the human family in all ages has fully and conclusively demonstrated the correctness of their views.

§ 15. In the same circumstances and habits of life, they affirm, one enjoys good health and another is frequently or continually diseased,—one dies early, and

another reaches an advanced period of life, while people of very different, and even opposite circumstances and habits, experience the same uncertainties and share the same fate;—some enjoying health, and others being afflicted with disease;—some finding an early grave, and some attaining to old age;—and in all circumstances and habits, the vigorous and robust often die suddenly in the opening of manhood or the very prime of life, while the feeble and the sickly frequently drag out a protracted and miserable existence. Survey, say they, the extended map of the earth, and we find the inhabitants of one portion feeding on the putrescent carcasses of dead animals,—others on noisome vermin and reptiles,—others, on a mixture of animal and vegetable substance,—others, on vegetables exclusively, and others, allaying their hunger, and to some extent supplying the alimentary wants of their nature, with unctuous earths.—Some indulging freely in the use of tobacco,—others in opium,—others in arrack,—others in rum, or some of the numerous forms of alcoholic liquor; and yet, with these differences of dietetic habits, and all the difference of climate from the equator to the poles, we find, it is said, among all the different tribes and portions of the human family, about an equal share of health and disease,—premature death and extended life. And, while the Esquimaux feasts with gustatory satisfaction and delight on his carrion flesh, and derives from it the most healthful and invigorating sustenance to his body,—the Hindoo, with equal gustatory enjoyment and health, makes his repast on his dish of rice;—yet, if the diet of these two be exchanged, and the Esquimaux be fed on the rice and the Hindoo on the flesh, both will be disgusted and both will be made sick.

§ 16. Thus, we are told, it is completely demonstrated by the experience of all nations and all ages, that human

life and health and disease are matters either of absolute fatality or perfect contingency; and that, in regard to them, there is no fixed philosophical relation between cause and effect;—and therefore, the life, health, disease, and diet of man, cannot be governed by fixed laws, nor made matters of systematic science.

§ 17. This reasoning, at first view, appears forcible and conclusive; but when thoroughly examined it proves to be entirely fallacious:—and the more deeply and extensively we push our investigations on this subject, the more fully are we convinced that human life, health, disease, diet, and general regimen are matters of as pure and nearly as exact science as mathematics.—Indeed, human physiology, in the full sense of the term, is far the most profound and important science that has ever occupied the attention of man;—and in order to the most perfect understanding of it, a knowledge of all other sciences is requisite.—In fact, it may almost be said that this science consists of the sum of all other sciences systematized into one;—and the only reasons why the notions of mankind are so vague and erroneous on this subject are that they never study it as a science;—and most or all of their opinions are the results of *feeling*, or what they mis-call experience, rather than of deep reasoning and philosophical investigation. Nor is it surprising that it should be so, when the nature of man as a rational animal, and the circumstances in which he is placed and the influences which act on his natural and moral susceptibilities, are accurately considered.

§ 18. In the rude state of nature, the wants of man are few and simple.—If hungry, he plucks the fruit from the bough of the tree, or gathers some nutritious substance from the earth and satisfies his want.—If thirsty, he stoops to the clear fountain or stream,—or with his hand,

or with a folded vegetable leaf, lifts the pure beverage of nature to his lips, and answers the instinctive demand;—or perhaps more naturally, he satisfies this want with the juices of succulent fruits.—If cold, he wraps his body in the skins of beasts;—if oppressed with heat, he retires to the cool shade of trees.—When the sun sinks below the western horizon, and the curtain of night gathers over him, he throws himself upon the bosom of the earth, or on some rudely prepared couch, and sleeps till the returning light rouses him, fresh and vigorous, from his slumbers:—or if he inhabits a portion of the globe where darkness prevails for months, he sleeps and wakes according to the instinctive demands of his nature.—The apparent revolutions of the sun—the waxing and the waning of the moon and the changes of the seasons, constitute his only chronometer.

§ 19. In all this, it is manifest, that the *rational powers* of man are little employed in investigating the adaptation of his diet and habits to the laws of organic vitality.—Possessed of the instincts common to all animals, he *feels* his wants, and by the *feeling*, is prompted like other animals to satisfy them;—and, in doing this, he is governed by those instinctive powers of smell and taste, which enable him with utmost accuracy to discriminate between esculent and poisonous substances. And, if reasoning powers of a higher order than those which are exercised by other animals, are employed by him, it is in devising the means by which his supplies are procured, rather than in ascertaining the fitness of those supplies to the real constitutional wants of his nature.

§ 20. As man gradually becomes removed from the simplest state of nature, by the artificial habits and circumstances of society, he finds it first *convenient* and then *necessary* to possess those rude utensils—the earliest spe-

cimens of human art—with which he prepares his food, and dips his water from the brook, and fits his clothing for his body.—No sooner are these things considered *necessary*, then the supply of them becomes of nearly as much importance as food and drink and clothing. This, in time, leads individuals to devote themselves wholly to the manufacture of such articles as the wants of society demand: and *this* leads to an increase of skill and knowledge in the manufacturing art, and a consequent improvement of the things manufactured: and this reacts upon society, and accelerates its progress towards what are called the refinements of civic life: and this, again, while it continually multiplies the artificial wants of man, increases the necessity for the supply of those wants: and the final result is that, the artificial wants of man become so numerous and so imperious that a large proportion of the time and powers of every member of society are employed in supplying them: and, in the progress of the development of this state of things, the several arts and sciences of civic life are originated and matured.

§ 21. Thus, from the simple instinct of thirst, or natural want of water, has grown the invention or discovery and manufacture of the numerous beverages or kinds of liquor drank by man, and of the boundless variety of cups, glasses and vessels of every description, employed in containing water, tea, coffee, wine and all other kinds of alcoholic and other liquors used as human drink.—And out of the simple instinct of hunger has grown all the devices and arts concerned in producing, procuring and preparing food, and the invention and manufacture of all culinary utensils; and all the dishes, tables and other articles used in cooking, holding and serving up the aliment of man. And out of the want of clothing, which was at first supplied by a light tissue of leaves or by the

skins of beasts, has grown the manufacture of the interminable variety of articles made of wool, flax, silk, cotton, fur, &c. &c.

§ 22. In the progress of these arts and operations, one want has created another, and caused a continual demand for the closest and most constant application of the mental powers of man to the investigation of the physical, mechanical and chemical properties of things,—and with reference to forces, motions, numbers, quantities, time, distance, &c. &c., till mathematics, astronomy, chemistry, and all other human sciences have been slowly developed and matured and become themselves, some of the most important wants of society.

§ 23. But it is obvious that, in this general progress of things, by which new wants are continually and rapidly generated and multiplied, there is little to lead the mind of man to study the laws of human life, or to examine the dietetic and other habits of civic life with reference to health and disease.

§ 24. The artizan who manufactured the first rude cup or goblet, probably never gave a thought to the question whether water or some other liquid is best adapted to the natural wants of man; and since him, the thousands who have been employed in the same line of art, have seldom, if ever, been led by their occupation to inquire whether wine, tea, coffee and other alcoholic and narcotic beverages are adapted to the real wants of the human body, or are consistent with the laws of life and health. On the contrary, the very employment and circumstances of every artizan, require the constant application of his mental powers to the principles and operations of his art, in order to his immediate success as an artizan, and to his ultimate pecuniary success as a member of society. The wants of civic life are so numerous, and

constitute so important a part of the very texture of social and domestic life, that every man finds nearly his whole time and attention taken up in supplying them.

§ 25. It is true, that disease multiplies in society in proportion as man removes from a pure state of nature, and becomes more and more an artificial being in his habits and circumstances:—and this leads to the study of the healing art,—and ultimately to the study of anatomy and physiology. But, even here, the general tendency of things is far less favorable to the accurate and profound study of the science of human life, than is generally supposed.

§ 26. Disease always precedes the physician:—and the sick are only concerned to know how they can obtain the most speedy relief from their sufferings. The question with them, and with their friends, is not, how they came by their sickness, or by what violations of the laws of life it has been induced,—but by what remedies they can remove the disease and restore health.

§ 27. The domestic therapeutics of the earliest stages of society is generally extremely simple:—and is perhaps, governed at first, by the morbid cravings of the patient,—by accident, and finally, by experience. If by any means the disease is removed, the remedies and measures employed are carefully remembered, and used again, when similar cases occur:—and in this manner, every tribe, and almost every family soon acquire their system of pharmacy and their theory and practice of medicine.

* By “a pure state of nature,” let it be understood, once for all, that I never mean the savage state; for I consider the savage state, in many respects, very far from the truly natural state of man, and therefore, I distinguish between the *rude* state of nature (§ 18) and the *pure* state of nature. By the latter, I always mean that state in which the condition, circumstances and habits of man are in strict and full accordance with the constitutional laws of his nature. (§ 774.)

§ 28. As society advances and diseases become more numerous and frequent, it follows as a necessary result, from the consequent order of things, that individuals become devoted to the study of remedies, and to the care of the sick;—and thus, physicians originate. The office is, perhaps, more frequently at first, confined to the priesthood, who employ with their simple remedies, an abundance of superstitious juggling and incantation and exorcism. In time, however, some master spirit like Hippocrates, rises up, and digests the chaos of crude elements, into something like order and system. But it is obvious that, from the first rude origin of these elements to their systematic arrangement, every thing is done simply with a view to *cure* the disease, and without any regard to its cause:—and, indeed, the disease itself is generally considered as the direct and vindictive infliction of some benevolent or malevolent, supernatural being or beings:—and therefore, in all the progress of the healing art thus far, not a step is taken towards investigating the laws of life and health, and the philosophy of disease.

§ 29. Nor, after medicine had received a more systematic form from the plastic hand of Hippocrates, did it lead its votaries to those researches which were most essential to its success, and which its great importance to society demanded:—but like religion and every thing else in the hands of man, it became blended with the grossest superstitions, errors and absurdities. Hence, from the earliest traditions of Egypt, until comparatively modern times, the history of medicine, with very limited exceptions, is a tissue of ignorance and folly—error and absurdity; and only serves to demonstrate the absence of that knowledge upon which alone, an enlightened and successful system of medicine can be founded; and to show to what extent a noble, and I might perhaps with pro-

priety say *divine* art, can be degraded, and perverted from its high capabilities of good, to almost unmixed evil, by the gross ignorance and sensuality and superstition and cupidity of man.

§ 30. In ascertaining and defining the symptoms of disease, with reference to the application of remedies, some of the ancients, certainly did much for the healing art; and they undoubtedly made considerable attainments in the knowledge of anatomy and surgery. But we ought to know that all this may be done, with almost entire ignorance of the laws of life, and the true philosophy of disease.—Still, however, it must be admitted that, with all the disadvantages under which he labored in regard to physiological knowledge, the therapeutic views of Hippocrates were such as justly entitled him to be called “the Father of Medicine.”

§ 31. In modern times, anatomy and surgery have been carried perhaps, nearly to the top of perfection; and very great attainments have been made in physiology.—The science of human life has been studied with intense interest and remarkable success:—but this has been confined to the devoted few; while, even in our own day, and in the medical profession itself, the general and powerful tendency of things, is adverse to the increase and diffusion of scientific knowledge, in regard to human life, health and disease.

§ 32. Intent, as all men are, on present enjoyment, they are little inclined to practise present self-denial for the sake of a future good, which they consider, in any possible degree contingent; and will only consent to bear the cross when compelled by necessity, or when they find it the only means of shunning imminent destruction; or of escaping from intolerable evils. Hence, so long as mankind are favored with even a moderate degree of

health, they rush into the eagerly desired excitements of their various pursuits, and pleasures and indulgences: and nothing seems to them more visionary and ridiculous, than precepts, and regulations and admonitions concerning the preservation of health.—While they possess health, they will not believe that they are in any danger of losing it;—or if they are,—nothing in their habits or practices can have any effect, either in destroying or preserving it: nor can they be convinced of the universal delusion that, if they enjoy health, they have within themselves the constant demonstration, that, their habits and practices are conformable to the laws of health, at least, in their own constitutions. They will not therefore, consent to be benefited, contrarily to what they regard as necessary to their present enjoyment, either by the experience or by the learning of others.

§ 33. The consequence is—as a general fact—that, while in health, mankind prodigally waste the resources of their constitution, as if the energies of life were inexhaustible:—and when, by the violence or by the continuance of their excesses, they have brought on acute or chronic disease, which interrupts their pursuits and destroys their comforts, they fly to the physician, not to learn from him, by what violations of what laws of life and health, they have drawn the evil upon themselves,—and by what means they can in future, avoid the same, and similar difficulties; but, considering themselves as unfortunate beings, visited with afflictions which they have in no manner been concerned in causing, they require the exercise of the physician's skill in the application of remedies by which their sufferings may be alleviated and their disease removed.—And in doing this, the more the practice of the physician conforms to the appetites of the

patient, the greater is his popularity, and the more cheerfully and generously is he rewarded.

§ 34. Every thing therefore, in the structure and operations of society, tends to confine the practising physician to the department of therapeutics, and make him a mere curer of disease:—and the consequence is that, excepting the few who are particularly favored by their situation as public teachers, the medical fraternity, even of the present day, have little inducement, or opportunity, to apply themselves to the study of the science of human life, with that devotedness and zeal and perseverance, which the profoundness and intricacy of the subject require;—while on the other hand, almost every thing by which men can be corrupted, is continually presented, to induce them to become the mere panders of human ignorance and depravity and lust:—and if they do not sink their noble profession to the level of the vilest empiricism, it is owing to their own moral sensibility and philanthropy and love of virtue, and magnanimity, rather than to the discriminating encouragement which they receive from society, to pursue an elevated, scientific, professional career.

§ 35. Thus, we see that, both the natural and acquired appetites, propensities and habits of man, and all the circumstances of life which act on his natural and moral sensibilities, concur to divert his attention from the study of the science of human life, and fix it on present self-enjoyment, and on the pursuit of the means of supplying his natural and artificial wants. And hence, he is left to *feel* his way to, or gather from what he calls *experience*, most or all the conclusions which he embraces, in regard to the laws of life, health, and disease.

§ 36. This source of knowledge is as utterly fallacious, as it is delusively specious; and the more deeply and exten-

sively mankind are betrayed by it, the more totally blinded do they become to its treachery; and the more zealously and confidently do they contend for its validity.

§ 37. Every one *knows* from his own *feelings* and *experience* precisely what kind of constitution he has; and what agrees and what disagrees with it;—and every body knows exactly what agrees and what disagrees with his own stomach;—and is taught by his own experience, what is best for his constitution and his health and strength and comfort.—And surely, if a lady has the head-ache, she knows her own feelings better than any body else does:—and if she drinks a good strong cup of tea and the pain leaves her head, nobody ought to be guilty of so gross an insult to her understanding, as to attempt to convince her that, tea is a poison, and that, her use of it is a principal cause of her head-ache:—for she knows that she always feels better after drinking tea; and from fifteen or twenty years experience, she knows that, there is no better remedy for head-ache, than a good strong cup of tea:—for she has been subject to the head-ache for nearly twenty years, and the frequency and violence of the turns have gradually increased upon her from the first, till she is now obliged to give up all business, or pleasures, and take to her bed for the whole day, whenever she has a turn, which is certainly as often as once a week, and sometimes more frequent; and she has always found that, tea is “the sovereignest remedy in the world” for head-ache!—Who can reason against such facts as these? or have the temerity to advance a theory which contradicts the universal experience of the human race? It must be confessed that the enterprise is an arduous and a daring one; and is cheered by no encouraging prospect, except the possibility that mankind can be undeceived in regard to the validity of their feelings and their experience, as rules of life.

§ 38. I do not however, wish to convince my fellow creatures that they have no *feelings*;—nor that they do not know when, and how much they feel: but I wish to convince them that, the kind and degree of their feeling, by no means, teach them what causes it, nor the principles upon which its existence depends.—I am willing to concede to the lady, that, she knows best how her own head-ache *feels*; and that she knows it is relieved by a cup of tea.—But does she know either, the remote or immediate cause of her head-ache?—Does she know the vital properties and powers and functional relations of the organs of her body; and does she accurately understand the healthy and the diseased affections and sympathies of those organs?—Does she know the qualities of the tea in relation to the vital properties and functional powers of her system?—Does she know the direct and the ultimate effects of the tea on her system?—How it produces the pleasurable feelings, and how it removes the pain of her head?—And does she know whether the very effects of the tea, by which the paroxysms of her head-ache are relieved, are not the principal source of her head-ache, and the main cause of the frequency and violence of the paroxysms?—If not, what are her feelings and experience worth, to herself or others, as rules of life, by which she, or any one can judge of the fitness of her habits, to the laws of life and health?—I answer, not a farthing!—Nay, indeed! they are worse than nothing! mere delusions by which we are decoyed from step to step along the specious labyrinths of sensuality and suffering. And such, with rarely an individual exception, is the universal experience of mankind!—I acknowledge that, they *feel*; and that they know whether their feelings are pleasurable or painful.—But do they know physiologically *how*, or *why* they feel; and understand the relation of their feelings to

the powers and laws of vitality;—and to the condition and functions of the living organs?—I acknowledge that, by virtue of a vigorous constitution, many may live years, and some, even to what we call old age, in the enjoyment of ordinary health, in spite of habitual violations of the laws of life and health. But does this constitute an experience which proves the correctness of their habits?—or, at least, that those habits are not unfavorable to life and health, in certain constitutions?—Most evidently it does not!

§ 39. It has been justly observed by a distinguished philosopher that, “men in their inductive reasonings deceive themselves continually, and think that they are reasoning from facts and experience, when, in reality, they are only reasoning from a mixture of truth and falsehood. The only end answered by facts so incorrectly apprehended, is that of making error more incorrigible. Nothing, indeed, is so hostile to the interests of truth, as facts incorrectly observed.”* And on no subject are men so liable to misapprehend facts, and to mistake the relation between cause and effect, as on that of human life, health and disease. Without the most profound physiological and pathological knowledge and discrimination, it is not possible for them to avoid self-deception. They constantly mistake the *causes* of their feelings, and misunderstand the physiological and pathological character of the feelings themselves.—And, judging of the qualities of things by the feelings which they produce,—and without considering that even the most baneful substances may be made the causes of pleasurable stimulation to depraved organs, they inevitably confound good and evil,—their facts become falsehoods,—their inductions erroneous,—and their experience, a tissue of error and absurdity, which serves only to mislead and to betray them.

* Playfair's Analysis of Bacon's Novum Organum.

§ 40. Nothing is more certain therefore, than that, the only way by which mankind can attain to correct notions concerning human life, health, disease, regimen, &c., is to apply their intellectual powers assiduously to the study of the subject as a science; and this will lead them, not as mere animals possessed of sensibility and consciousness, and the voluntary power of sensual indulgence, but as rational beings, over a most extensive and interesting field of research and investigation.

§ 41. Could we seize upon vitality itself, and ascertain its essence, we might, perhaps, be able to reason from its intrinsic properties and powers, to all conclusions necessary for our use, with a more limited extent of argument, and much less help from other sciences than we now find requisite. But we know nothing of the essence of life, and therefore we can only know its peculiar properties and powers, and laws, by accurately ascertaining the character of its manifestations and effects in relation to the ordinary laws and properties of inorganic matter.

§ 42. We perceive therefore, that the science of Human Nature is most comprehensive as well as complicated and profound:—that it extends, not only over the whole man, embracing all his moral, intellectual, animal and organic properties, and reaching even to the vital forces and affinities, from the action of which, result the several arrangements, structures, tissues and organs of the body, but, in order to come at the truth on all these points, and ascertain how far the matter of the living body is subject to the common physical laws of the inorganic world—how far and in what manner the living body resists and overcomes those laws, and to what extent the vital economy is affected, and life modified by the presence of chemical agents, the force of chemical affinities, and the power of physical laws, it necessarily goes still farther

and investigates the properties and laws common to all matter; and endeavors, in its analytical progress, to arrive as nearly as possible at the primordial form and essential nature of matter itself; and thus prepares the way to ascertain the differences and distinctions between inorganic and organic matter, and to find out the properties and laws peculiar to all organized matter, or all living vegetable and animal bodies; and the differences and distinctions between vegetable and animal bodies, and the properties and laws peculiar to the latter; and in this way, finally brings us to the study of the particular anatomy and physiology and psychology of man.

§ 43. The subject is immense! yet it is, in all its details, replete with interest to every human being. Man finds himself upon the theatre of life, full of susceptibilities, surrounded by innumerable influences, and acted on at every point; and he is continually conscious, not only of his existence and the action of surrounding influences, but of an unceasing desire for happiness. Has God implanted this desire as a fundamental principle of action, in our nature, merely to tantalize us in the vain pursuit of what has no reality? or is the desire itself, a living proof that, our benevolent Creator has fitted us for happiness—not only in a future state, but here—in soul and body; and adapted every thing within us and around us, to answer this desire, in the fulfilment of those laws of life and health and happiness which he, in wisdom and in goodness, has established in the constitutional nature of things?

§ 44. Surely our heavenly Father cannot but prefer our happiness at every instant of our lives; and if we are not happy it cannot be because he has not endowed us with the capability of being so, and adapted earth and all terrestrial things to all that he has made us capable of being.

§ 45. Our disquietudes, and diseases, and untimely death must therefore spring, not from the fulfilment, but from the infraction of the laws of God; and it becomes us humbly, yet diligently to endeavor to ascertain those laws and to obey them and be happy; and thus fulfil the benevolent purposes of God, and glorify him in our spirits and our bodies, which are his.

§ 46. It is impossible to attain to a full understanding of these things without a determined and persevering application of the mind;—and for the sake of knowledge so important, we must be willing to submit even to the drudgery of that application which at first, is made only with the hope of being rewarded when the task is mastered, and hidden things are brought to light by penetrating diligence.

LECTURE II.

The variety of material forms—Their origin—Apparent difference between organic and inorganic matter—Great variety of organic forms—Systematized into a few classes—Order and design in every thing—Organic and inorganic bodies resolved to the same elements—All things in the material world resolved to a few simple substances—Wonderful powers of vital chemistry in vegetable and animal bodies—All kinds of aliment converted into the same organized substances—The various forms of matter composed of minute primordial atoms, the same in organic and inorganic bodies—differently arranged—Intimate relations between all material forms—What is matter?—Moses' account of the creation!—St. Paul's explanation—A single element of matter—Opinions of Braconnot, Sir Humphrey Davy, Dr Herschel, Dr. Arnot, Sir J. F. W. Herschel, Dr. Prout and others—Original formation of things—The agency of an intelligent and omnipotent Creator necessary—The intrinsic properties of matter could not produce the results of nature—No law nor property of matter known to be essential to it—We know no more of matter than of spirit—Original forms and primitive combinations of matter—Number of chemical elements—Water, how formed—Rocks—Earth, &c.—The Neptunian and Plutonian theories of Geology—Natural elements few, or one—Essentially the same matter in all forms—Inorganic affinities could not produce organized bodies and life—Opposition of organic and inorganic affinities—Life not the result of organized matter, but the contrary—The inorganic world left to itself must have remained eternally so, without a blade of grass—The necessity for an intelligent and omnipotent Creator.

§ 47. IF, in our imagination, we assume some elevated stand, and contemplate the surface of our globe, we behold mountains and valleys, hills and plains,—bounded by

oceans and intersected by rivers and streams, and clothed with vegetation, and swarming with a vast variety of animals. Pleased with the interesting view, we are naturally led to inquire,—whence all this beautiful variety of things? Do they constitute but a part of an eternal succession of material and living forms?—Or is this globe with “all that inhabits it,” but the wreck or fragment of something more magnificent and vast?—Or are these things the blind result of chance?—Or, far retired behind these mighty works, is there a mightier Architect, whose power and wisdom and design, for some great purpose of benevolence, created and constructed every thing?—But, in vain we question nature in this general manner! No distinct and definite answer is afforded us.—If, with the spirit of philosophic inquiry, we descend from our elevated situation and general view, and approach to a nearer and more intimate inspection of the several parts, of the great scene before us, we behold the mineral and vegetable and animal kingdoms displayed around us in splendor and luxuriance and beauty and enjoyment. Profusion and variety and disorder seem, at first glance, to prevail throughout the whole. Between inorganic, and vegetable and animal matter, there appears to be not only a distinction of forms, but an essential difference even in the ultimate elements.

§ 48. Turning our more particular attention to the organic world, it appears, at first view, as if nature had spontaneously thrown out an interminable variety of forms, without regard to order or design. But when we come to a more close and careful examination, we discover that the most perfect order pervades the whole, and that interminable as the variety at first appeared, all may be arranged into a few classes, each of which embraces but a limited number of species:—and the more rigor-

ously we scrutinize the individual forms of things, in order to ascertain their peculiar structure and properties, and constitutional principles and laws, the more clearly we perceive order and design in every part, and perfect fitness and harmony reigning through all. At each advancing step, we discern more and more distinctly on every part, the deep and indelible hand-writing of Creative Intelligence, and Design and Goodness!—In every animal—in every vegetable form, God has stereotyped a living alphabet, by which we can spell out his power and wisdom and benevolence!

§ 49. Not satisfied with these discoveries, we begin more boldly to demand of Nature the disclosure of her secret things, and in the crucible, and by other modes of analysis, compel her to divulge her most hidden principles. All living bodies, and the atmosphere and ocean and the earth, even to her inmost entrails, are explored. The solid forms of matter melt beneath the fiery inquisition! The earths shrink into metallic bases! and these again, if still pursued with sufficient intensity of heat, vanish into thin vapor—apparent nothingness! And we are astonished to perceive that, essentially different as we supposed the animal and vegetable and inorganic substances which we subjected to our analytical ordeal, yet the results exhibit the same ultimate elements in all, or only differing in their proximate conditions.

§ 50. Encouraged by our success, we eagerly urge onward our experiments, till we seem about to step upon the threshold of ultimate analysis; and arrive at the full conviction that, every fluid and every solid substance in the world—even the hardest minerals, may, with sufficient heat, be converted into thin air or gas!—and we learn that all things composing and inhabiting this globe of ours—organic and inorganic, may, by chemical anal-

ysis even in the hands of man, be resolved into a few forms or substances, which in the present state of science we find convenient to call elements.

§ 51. But the vital alchemy of the organic laboratory, leaves the chemist's crucible, and the more simple operations of inorganic nature, far behind in its energy of analysis and in its creative aggregations and arrangements; and seems to possess the power not only of decomposing most, if not all of those substances which are called elements, but also, of actually transmuting them into each other.

§ 52. "The seeds of various plants," says a distinguished chemist, "may be placed in pure sea-sand, or even leaden shot, and nourished with nothing but pure distilled water, and the common atmosphere, and the sun's light and heat, and the seeds will sprout and the plants grow and thrive, and attain to maturity, elaborating for themselves, out of the distilled water and the atmosphere, all their own nutriment, and properly arranging and composing the several vegetable structures and substances, and producing the several vegetable properties. And if this vegetable matter thus produced, be carefully preserved and accurately analyzed, the various earths, the alkalies, acids, metals, carbon, sulphur, phosphorus, nitrogen, &c. may be obtained the same, or nearly the same as if the plants had grown in their natural soil."

§ 53. "It is well known," says Dr. Turner, in his Elements of Chemistry, "that many plants grow when merely suspended in the air. In the hot-houses of the botanical garden of Edinburgh, for example, there are two plants, species of the fig tree, the *Ficus australis* and the *Ficus elastica*, the latter of which, as Dr. Graham informs me, has been suspended for four, and the former, for nearly ten years, during which time, they have continued to send out shoots and leaves."

§ 54. "The Aerial Epidendrum, a beautiful plant of Java and of the East Indies beyond the Ganges," says an eminent physiologist, "has no roots nor any apparent organs of nutrition, but lives alone on air and the vapor of the atmosphere. It is said to be no uncommon thing for the inhabitants to pluck it up on account of the elegance of its leaves and the beauty of its flower, and the exquisite odor which it diffuses, and to suspend it by a silken cord from the ceiling of their rooms, where, from year to year, it continues to put forth new leaves, new blossoms and new fragrance, excited to new life and action only by light and heat and the surrounding atmosphere."

§ 55. Here then, the atmosphere, with the assistance of light and heat, is converted, by the vital forces of the vegetable organic economy, into fluid and solid vegetable substance, color and fragrance; and if this vegetable matter be carefully analyzed, it will afford many of those substances, or forms of matter, which chemists now call elements, and which no analysis that they are capable of making, has, as yet, been able to detect in the substances by which the plants were nourished.

§ 56. If therefore, earths and alkalies and acids and metals and sulphur and phosphorus, and other equally simple substances, may be elaborated by the vital power of the vegetable economy from the oxygen and nitrogen and hydrogen and carbon of the common atmosphere, with what propriety can they be considered elements, or primordial forms of matter?

§ 57. "The cerealia produce pure silex or flint, though not a particle of it is to be found in the soil in which they grew, nor in the fluid by which they are nourished. Plant in the same soil, the sugar cane, the aloe and the nightshade,—water them with distilled water, and let them grow

side by side, warmed and invigorated by the same heat and light and atmosphere, and the juice of the one will afford nutritious sugar—of another, the medicinal, intensely bitter aloes, and of the third, a substance with but little taste, but a deadly poison. From the sap of the peach tree, are produced the woody structure, the verdant foliage, the blossom with its beautiful tints and delightful fragrance, and the delicious fruit; while in the leaves and kernel, is formed a pungent bitter, and the prussic acid, which, in its concentrated state, is one of the most deadly poisons known. The may-apple or mandrake which grows wild in our woods, bears a fruit which is esculent and fine flavored when ripe, while its root is a purgative of about the same power as jalap and the leaf is actively poisonous.”

§ 58. “Thus, from the common sap,” says Dr. Good, “which may itself be elaborated entirely from pure water and the atmosphere, with the help of light and heat, are secreted a variety of substances of different, and frequently of opposite powers and qualities:—substances nutritive, medicinal or destructive; and often in the same individual plant, some of its organs secrete a wholesome aliment while others secrete a deadly poison.”

§ 59. Nor is the vital economy of the animal system less wonderful in its analytic and synthetic powers. From all the varieties of aliment with which it is supplied, whatever may be the chemical properties of the food, it constantly, and with utmost integrity, during health, produces chyme, chyle and blood, of very nearly the same chemical character:—and whatever may be the kind of nourishment received into the stomach, in a healthy state of the system, the blood elaborated from it, regularly affords the appropriate supply of materials to every structure and substance of the body; whether the particu-

lar properties or substances derived from an analysis of the several structures, be found in the aliment or not.

§ 60. Neither in the chyle nor in the blood is any gelatin ever found, and yet the most extensive structure of the whole body is principally composed of this substance; and the quantity of carbon eliminated by the human body, seems very greatly to exceed the quantity received into it in any appreciable manner.

§ 61. Moreover, the vital economy seems to possess the power of varying the quantity of particular qualities and substances produced by it, according to the condition and demands of the system,—periodically supplying from the common and ordinary current of blood, without any known variation in the food from which it is elaborated, a very large increase of appropriate nourishment, for particular structures,—and at the same time, regularly sustaining the general function of nutrition, in every part and substance of the system.

§ 62. Whatever may be the kind or quality of the food from which it is elaborated, the blood of man will always afford, by chemical analysis, a considerable quantity of iron. Several other metals and other substances are also procured in the same manner, from the animal system, which it would be difficult, if not impossible, to account for in any other satisfactory way, than by admitting the power of the vital economy, to produce, from a nearly homogeneous chyle, various substances which in chemistry, are considered not only opposite in their qualities, but of essentially different elements.

§ 63. In the same animal, from the same vital current which nourishes the flesh, that would be perfectly safe and nutritious for human aliment, is secreted the most deadly poison. The flesh of the rattlesnake, is eaten by many people, as a great luxury:—and even its blood

may be received into the human stomach or put upon a fresh wound with perfect safety, and yet, from the same blood, is secreted a poison, which if mingled with the blood of our systems, will, with almost irremediable certainty, prove fatal in a very short time.

§ 64. Besides these natural and ordinary operations of the vital economy of the animal system, it is no uncommon thing for protracted irritations, and diseased action to produce results, totally different from those of the normal or healthy and regular functions of the organs; and the blood, which in the healthy condition and action of the parts, regularly supplies appropriate nourishment for the soft solids, is made to yield the materials for the structure of bone:—and thus, ossification has taken place in the heart and other important organs, to an extent which has often proved fatal to life.

§ 65. All the beautiful variety of things therefore, which we, at first, supposed essentially different, may be resolved by the keen scrutiny of analytical science, to a very few substances which are called elements, because they have hitherto withstood the utmost powers of analysis in the hands of man;—and yet, such have been the astonishing results of human investigations, that men of high and wonderful attainments in science, begin to tell us that, “it is scarcely possible to say what substances are not compound bodies:”—and still, as we have seen, the nicer alchemy of the organic laboratory, penetrates far beyond the reach of human science, and seems to have the power to decompose and combine and generate with almost a creative energy.—And the sacred Scriptures affirm that, “the time shall come when all these things shall be *dissolved* and the *elements* shall melt with fervent heat.”

§ 66. If now we interrogate Nature in another mode,

new revelations of her secret things, astonish and delight us: and from her disclosures and her intimations, we are led to the conjecture, and feel ourselves urged to the conclusion that, the various forms of matter, are composed of almost infinitely minute atoms; (§ 78, 79;) and that these little molecules are precisely the same, whether in animal, vegetable or inorganic structure:—precisely the same, whether composing the animated flesh of man,—the beautiful and fragrant flower or delicious fruit of the vegetable,—or the hardest mineral,—or the most subtil and elastic air:—and that it is only the different arrangements or aggregations of these atoms, that constitute the different material substances and qualities and forms—organic and inorganic. Nor is it probable that, in the various transformations of matter, which are continually going on, the analysis that takes place in the processes of Nature, often approaches near to the primordial atoms;—but molecules composed of myriads of those atoms, may be the ultimate forms in most of the ordinary changes of composition and decomposition in nature.

§ 67. Thus,—of those forms of matter which in chemistry are at present considered elements, different aggregations of the same molecules, make substances not only of entirely different natures, but of properties as different as those of aquafortis, and the balmy air which we breathe,—of sugar and vinegar,—of charcoal and diamond.—And thus again, by differently arranging the same molecules of matter, red, orange, yellow, green, blue and other colors and tints are produced—and in like manner, are formed the most fragrant and the most offensive odors; and the different qualities of sweet and sour and bitter &c. And there are reasons for believing that, light and heat and electricity and magnetism, instead of being essentially different substances, are but the results of particular

aggregations or arrangements and conditions of the same primary atoms of matter.

§ 68. If these things be so, they reveal to us most intimate relations between all material forms and substances, which hitherto, we have little thought of;—and we learn from them, our natural fellowship with earth and ocean and the atmosphere and every thing around us.

§ 69. What, then, is matter?—and what was its primordial form?—and what are its essential properties?

Moses instructs us that, “In the beginning God created the heaven and the earth!”—And having made this general predication of his subject,—he commences a brief history of the creation, in detail; and declares that, previous to the creation of the earth, it was “*emptiness and nothing*,”—or had no perceptible existence:—for such is the radical and primitive sense of the Hebrew words in the original text; and such is the sense which the apostle Paul, who was a learned Hebrew scholar, gives them, when speaking of the same subject, in his epistle to the Hebrews. “Through faith,” says he, “we understand that the worlds were formed by the word of God; so that the things which are seen were not made of things which do appear.”—The writer of the book of Job and the prophet Isaiah also use the same Hebrew words in this sense.

§ 70. There is nothing in the Hebrew text, therefore, to justify the notion that our globe was formed out of a chaotic mass of matter, which might have been the wreck of some other planet, or of a comet, or fragment of the sun: but the true sense of the passage is nothing more nor less than that, before God created our globe,—this material world of ours had no perceptible existence—it was “*emptiness and nothing*.”

§ 71. The interesting question therefore still recurs;—

What is matter?—which we see displayed around us, in such multitudinous forms of magnificence and beauty and life and activity and sensibility and passion and enjoyment?

§ 72. From the many interesting facts and considerations which have now been presented, and a multitude of others which may be observed by the philosophic inquirer, on every hand, are we not urged to the conclusion that all these material forms and substances and qualities, and things, which now compose our palpable universe, are but the different modifications, or arrangements, of the same primordial atoms which constitute the *SINGLE element* or *ESSENCE of all matter*?

§ 73. It is true that, the demonstrations of human science, have not yet arrived at this grand conclusion; and it is possible that they never will:—but it is equally true that the glorious march of scientific discovery, seems continually approaching toward this great point; and that every advancing step of analytical demonstration, while it multiplies the proximate forms, draws apparently still nearer to the single element of matter. And it is an interesting fact that, many of the greatest minds which, in modern times, have been devoted to the pursuits of natural science, appear almost simultaneously, as if inspired by Nature's great Spirit of Truth, to perceive indications of such a final consummation of analysis, and to intimate their conjectures of a single element; or, at most, a very few.

§ 74. "Oxygen and hydrogen with the assistance of solar light," says Braconnot, "appear to be the only elementary substances employed in the constitution of the whole universe: and Nature, in her simple progress, works the most infinitely diversified effects, by the slightest modifications, in the means she employs."

§ 75. "A very few elementary bodies indeed," says Sir Humphrey Davy, "and which may themselves, be only the different forms of some *one and the same primary material*, constitute the sum total of our tangible universe of things."—And that distinguished philosopher, Dr. Herschel, has advanced the opinion, that "light is the source of all substances and the basis of all worlds."

§ 76. "Whether those substances which, in the present state of science, are considered elements," says Dr. Arnot, "are in truth, originally and essentially different, or are only the *one simple primordial matter*, modified by circumstances, as yet unknown to us, we cannot at present positively determine."

§ 77. In a truly able and exceedingly interesting preliminary discourse on the study of Natural Philosophy, by J. F. W. Herschel, Esq. the same important idea is fully advanced. "Philosophical chemistry," says Mr. Herschel, "no more aims at determining the *one essential element, out of which all matter is formed—the one ultimate principle of the universe*, than astronomy at discovering the origin of the planetary movements, in the application of a determinate projectile force in a determinate direction; or geology, at ascending to the creation of the earth. **THERE MAY BE SUCH AN ELEMENT.** Some singular relations which have been pointed out, in the atomic weights of bodies, seem to suggest to minds fond of speculation, *that there is*—but philosophical chemistry is content to wait for some striking fact, which may either occur unexpectedly, or be led to by the slow progress of enlarged views, to disclose to us its existence."

§ 78. "The discoveries of modern chemistry have gone far to establish the truth of an opinion entertained by some of the ancients, that the universe consists of dis-

ting, separate, indivisible atoms, (§ 66.) or individual beings, so minute as to escape our senses, except where united by millions, and by those aggregations making up bodies of the smallest visible bulk."

§ 79. "What is proved concerning the atomic theory," (§ 66.) says Mr. Whewell in his admirable treatise on Astronomy and general Physics, "is that, chemical and other effects take place as if they were the aggregate of the effects of certain particles of elements,—the *proportions* of which particles are fixed and definite."—And Dr. Prout, in his profoundly scientific treatise on Chemistry and Meteorology, says—"By element is here meant a principle that is not made up of others, and which consequently possesses an absolute and independent existence. Whether *ONE* or more such elements exists is not now our object to inquire. The astonishing discoveries of modern chemistry, have shown that many of those substances, formerly considered as elements, are in fact compounds: and, as the science of chemistry is still progressive, it is probable that with the enlargement of its boundaries, there will still be a further diminution of the number of those substances which are, as yet, held to be simple."—Indeed the general train of reasoning throughout the whole of this very learned and exceedingly interesting treatise, embraces the supposition of only *one essential form of matter*.

§ 80. If therefore, any importance may justly be allowed to the opinions of those who are devoted to the pursuits of science, and who occupy eminent stations in the scientific world, we are here, by high authority, decidedly corroborated in the conclusion that the minute atoms of a single element constitute the primordial forms of matter,—by the various combinations, arrangements and aggregations of which, all the diversified and interest-

ing forms of things in our material world are produced.

§ 81. Having pursued our analytical inquiry concerning the nature and original form of matter, through the various researches of human science, and the still more discriminating and wonderful processes of the organic vital economy, till we have arrived, with the support of demonstration, apparently near to a single ultimate principle, with many known truths and manifest analogies leading to, and justifying the hypothesis of a single essence, or original element,—it now becomes necessary for us to travel down the deeply interesting course of synthetical arrangement, and conformation, till we have again returned to the present, existing forms and conditions of things, in order that, by such investigations, we may as clearly, and as fully as possible, ascertain the laws of constitution and relation, appertaining to the various forms of matter, and modes of being: and particularly such, as are connected with the existence,—and affect the condition of the human race.

§ 82. Here we are met, however, at the very outset of our career, by the exceedingly important question;—How could such various forms and qualities of matter, be produced from the atoms of a single element, by the action of any intrinsic, physical properties or powers?—This interesting interrogation brings us at once, to the great point at issue between Materialists and Theists. And it must frankly be confessed that it is not easy to conceive of the possibility, that the present variety of material forms and modes of existence, could have resulted from different aggregations of the atoms of a single element, nor of fifty elements, by the exclusive action of any intrinsic affinities or properties of the elementary atoms, or forms of matter.

§ 83. If there ever was a time, when the atoms of a

single element or of fifty elements, lay in a quiescent state, with undisturbed affinities, then that state must have remained forever, if some disturbing cause had not been introduced, to excite the action of those affinities and produce combinations and new forms of matter:—and when those affinities thus excited, had all exhausted their activity in such combinations, there they must eternally have continued—bound by the laws of primitive conjugation, unless some new disturbing cause had again been introduced;—and so on, *ad infinitum*—matter would expend its chemical activity, in every action that took place, and be totally destitute of the ability to take on new action and to change its form, without the agency of some new, paramount disturbing cause, which should relax or overcome the law of its previous affinities, and superinduce another law of aggregation.

§ 84. To illustrate this point, let us suppose that the two kinds of air called oxygen and hydrogen gases, are original elements of nature, and that the atoms of which they are composed possess an intrinsic appetency or affinity, which being excited to action by the combustion of the two gases together, in certain proportions, will result in the production of a third and entirely different form of matter which we call water.—Suppose this room to be filled with those gases, in the proportion of two volumes of hydrogen to one of oxygen, and that they are completely secluded from the action and influence of all other causes:—here they would remain forever, without entering into that combination which forms water, unless some new cause is introduced to bring their latent affinities into the necessary action;—and if such a material cause were introduced, it must necessarily act upon the whole; and every atom of matter composing the two gases, would enter into the formation of water;—and here the

active power would be expended and matter would eternally remain in the form of water, unless again, some new cause were introduced, which would overcome those affinities, the action of which, resulted in the formation of water, and bring into play other affinities, whose action would produce other forms of matter; and here again would be the end of action from any intrinsic affinity or power of matter.

§ 85. But perhaps it will be asserted that, with fifty elements, we can form a countless number of proximate elements, and, with these, by the various possible combinations, and in the various possible proportions with the original elements, we can produce an infinite variety of substances, and forms, which, acting upon each other, as disturbing causes, can keep in eternal activity, the affinities of matter, and thus cause an endless transformation of material things.

§ 86. This, it is acknowledged, is true to a considerable extent, if all, that is assumed concerning the properties of elementary matter, be admitted:—and yet, there is a limit far more circumscribed, to the action of all these possible affinities and combinations, and proportions, than is compatible with the reasoning and hypotheses of atheistical philosophy:—a limit, beyond which, intrinsic atomic affinity and activity could not go:—and yet, beyond which, matter has been carried to a wonderful extent, by laws of arrangement, which counteract and suspend its more primitive affinities, and erect magnificent superstructures on the ruins of all previous forms and qualities.—It will be seen in the progress of our investigations, that there are forms and modes of material existence, resulting from the action of powers and qualities and affinities, which are so entirely different from—and in fact, opposite to all that can be considered the more

primitive atomic properties, that it is not possible they ever could have been, or ever can be produced by any intrinsic appetency or power of matter, even though we admit the existence of a thousand elements.

§ 87. But, although modern chemistry has distributed matter into more than fifty elements or simple substances, yet, is it not evident, from what has been advanced on the present occasion, that the elements of nature must consist of a much smaller number? and do there not appear to be many and strong reasons for believing that there is but a single original element, or essence of all matter? How extremely subtil and refined and sublimated, that material essence, in itself may be;—or what may be its distinction from, or proximity to spiritual substance,—it is not possible for us to form a clear conception, nor even for our imaginations to shadow forth an indistinct idea!

§ 88. Moreover, it is an interesting and important truth, that there is not a single known property or law of matter, of which human science can with certainty affirm that it is essential to the nature of matter. Even gravitation, the most universal and all-pervading property or law of matter, known to man, may only appertain to certain forms and conditions of matter, and not be in any degree, an intrinsic property of its essence. And this is true of magnetism and electricity and molecular affinity and every other known property. Indeed we know no more of the *nature* of matter, and of what are its essential properties, than we do of spirit.—To some extent, we can appreciate its forms, and ascertain the properties connected with those forms, and the laws which govern their motions and changes, but beyond this, our knowledge does not extend.

§ 89. Starting then, in our synthetical career, with the primordial atoms either of a single element, or of sev-

eral elements, we are compelled to acknowledge the agency, and intelligence and design of a creating and controlling Cause, who gave existence to those atoms and impressed upon them those virgin affinities or first laws of action, in obedience to which, they entered into those primal combinations which constituted the proximate elements of nature;—and these, again, received new laws of aggregation, which resulted in other forms and qualities of matter.—And thus, from step, to step in the great architectural work, the delineating and directing finger of Omnipotence, inscribed the constitutional laws of every form,—and by those laws, imparted to each form its own peculiar nature and properties and powers;—and defined the modes of conduct to all material action.—But how far these rudimental combinations and arrangements travelled down from the deep bosom of eternity, before they reached the present visible and tangible state of things, it is impossible for us to ascertain, without a knowledge of the first-made forms of matter. Nor is it of much importance to my present purpose that we should know, since our ignorance in this respect does not obscure the great principle of my reasoning. Those substances which we now call elements, are probably the results of many combinations of the primordial atoms; (§ 66.) and although most of them have hitherto resisted the powers of analysis in the hands of man, it is almost certain that, they are decomposed by the vital energies of organic forms, (§ 51.) and perhaps also, in many of the operations of inorganic nature.

§ 90. There is however, the greatest probability that the pure gaseous form, or form of vapor, is that which matter, in its progressive combinations, first assumed within the bounds which separate between the known and the unknown of things:—and there does not appear

to be any just ground of doubt that, the first palpable form of matter, was limpid water.—“The form of our globe, and of the moon, and all the planets and celestial bodies,” says Dr. Arnot, “demonstrates their original fluidity.”—The laws of constitutional relation between water and the vegetable and animal forms of matter,—indeed the whole economy of nature strongly indicates, if it does not prove, that water was the first *visible* and *tangible* form of this material world. And Moses in his brief history of creation, tells us that, before the heaven and the earth were formed, “darkness was upon the face of the deep (or the abyss) and the spirit of God moved upon the face of the waters.”

§ 91. Water was regarded by the ancients, as one of the elements of nature, and some, indeed, considered it the single original element, out of which all other material things were formed. Nor was it till the close of the last century that its compound nature was fully ascertained; and it was found to be formed by the chemical combination of two kinds of air or gas.

§ 92. I have already stated (§ 87.) that modern chemistry has distributed matter into more than fifty substances, which in the present state of science are called elements. Among these are two, which are denominated oxygen and hydrogen gases. Oxygen gas or air, in its separate and pure state, is a little heavier than the common atmosphere, of which it is a component part, and is the supporter of animal respiration—and the principal supporter of combustion. Remove it entirely from the atmosphere and we could not breathe,—and our lamps, and fires would be immediately extinguished, and many other evils would result, which there will be occasion to notice in the progress of my subject.—Hydrogen gas, is about fourteen times lighter or less dense than the

atmosphere, and is one of the most combustible substances known. If a quantity of oxygen gas be enclosed in one vessel and a quantity of hydrogen, in another, with a tube leading from each vessel and uniting in a common mouth, and if the gases be permitted to pass out in certain proportions, and be fired at the mouth where they meet and mix together, a bright flame will flash up, and at the same time a heat will be produced, of sufficient intensity to burn iron like dry wood, with a brilliancy of light which the eye can hardly endure,—and to melt down many minerals and other hard substances which the heat of a common fire will scarcely affect at all;—and the product of the combustion of these two gases, is water.

§ 93. Thus, from two invisible aeriform substances which burn with such intensity of heat and brilliancy of light, water is formed by their chemical combination in the act of combustion, and when thus produced, is one of the greatest extinguishers of combustion known in nature, and is many hundred times heavier than the same volume of the gases, from which it was formed!

§ 94. Nor is it necessary to suppose that, the water first formed, was in a turbid state, holding, in a semifluid solution, a chaotic mass of crude and undigested matter, which gradually settled into solid forms, and thus produced the rocks and finally the earthy mould which covers them.

§ 95. It is only the opinion that those different forms of matter which we call simple substances are, in their peculiar natures and properties, essentially and primordially different and distinct, which causes us to cling to the vague notion of a primitive chaos of partly fluid and partly solid matter, mixed together, in a kind of semifluid paste or pudding, because, with our limited views of things, we cannot easily conceive how rocks, and other

solid substances could be formed, without different, original, and appropriate kinds of matter, adapted to the structure of such substances.

§ 96. But if we keep in view the principles which we have been contemplating, and the truth of which, may be considered as more than probable—that all the different forms and substances and qualities of matter, are but the results of different arrangements and aggregations of the same primordial atoms, we shall find no difficulty in understanding how rocks and other solid substances could be formed from pure transparent water. Besides, it is a matter of continual fact, that various crystalline substances are so formed;—and certainly, we cannot consider it more incredible that such solid substances should be formed from a limpid fluid, than it is that they should be formed immediately from thin and invisible air, which is a fact of frequent occurrence in nature and in art.

§ 97. The transformation of fluids into solids, which seem to possess no properties in common with the fluids from which they were formed, is a very common process in the laboratories of chemists, and by no means an unfrequent one in the great operations of nature.

§ 98. It is not, therefore, in any degree necessary for us to suppose that matter, in its first visible and tangible state, consisted of a chaos of all the rudimentary substances mingled together in confusion,—but still possessing each its distinct existence and peculiar character. Pure, limpid water alone, with the surrounding atmosphere, and light and heat and electricity, contains amply sufficient material for all the purposes of nature in the magnificent architecture of our world of things.

§ 99. Those substances which we call oxygen and nitrogen gases, being more primitive forms of matter than water, of course, existed before it, and therefore

the atmosphere—such or nearly such as now surrounds the globe, existed before the formation of the world of waters.

§ 100. When the intimate connexion between light and heat and electricity and magnetism, is considered, and when we take into view, the important parts which these agents probably performed, in the progressive work of the original construction of the various forms of matter, we are philosophically led to suppose that they were the next productions in the order of creation. And according to the Mosaic record, after water was formed, light was commanded to be, and there was light;—and it is now pretty fully ascertained, that if light is not simply a peculiar arrangement and condition of the primary atoms common to all matter—if light and common matter are not convertible into each other, as suggested by Sir Isaac Newton, it does not emanate from the sun according to the doctrine of that distinguished philosopher, but is a substance so far independent of the sun as to be capable of existing without it.

§ 101. In intimate connexion with light, came heat and electricity and magnetism. These new agents being brought into operation upon fixed constitutional principles, by the almighty and creative Energy, began to act upon the atmosphere and water, according to laws of constitution and relation prescribed by infinite intelligence and benevolent design.—

§ 102. Evaporation began to take place, and the waters ascended up silently in the invisible state of vapor,—“and the waters were divided from the waters” and the firmament was established. At the same time new laws of aggregation were brought into action in “the mighty deep,” and the limpid water began to arrange itself in the beautiful and solid crystals of mineral structure. For

even here, in this inorganic aggregation, intelligence and design preside,—ordaining and exerting rigorous law; and every particle of matter, as by a kind of instinct, takes its constitutional place, with an order and precision and integrity, inflexible as necessity and irresistible as omnipotence!—observing with the exactness of geometry, the lines and angles of the structure into which it enters, as if each particular atom were directed one by one, by the designing finger of the Almighty.—And thus, the fluctuating waters were composed into the “everlasting rocks” varying in nice peculiarities, according to the delicate variations of the constitutional laws of aggregation.—And thus the foundations of the earth were laid and built up, and lifted their heads from out the bosom of the “vasty deep,” “and the waters under the heaven were gathered together into one place and the dry appeared.”*

§ 103. Heat, and frost and moisture, and various other agents acting upon the rocks which rose above the face of the water, caused a disintegration of their surfaces, and by this means a body of gravelly earth was formed as a matrix for vegetable seeds and roots. Thus, was the inorganic world completed. Nice varieties of gaseous and fluid and solid formations, continued to be produced by the ceaseless operations of nature. And deep in the bosom of the globe, fires were spontaneously kindled,

* Those geologists who oppose the idea that water was the first *perceptible* form of the matter of our globe contend that the crystals of what are supposed to be the primitive rocks are much more like those which we know to be the result of fusion than those resulting from solution. But the idea which I have advanced in the text, is that primitive crystallization resulted from electricity or galvanic action on pure aqueous matter; in which case the crystals would more resemble those which result from fusion than those from solution, but as a general fact, would be much more regular and perfect than either.

by which vast portions of the solid rocks were melted, and brought again into a fluid state, and earthquakes and volcanoes were produced: and by such means, the immense beds of unstratified rocks were formed, and the superincumbent layers thrown into disorder, and hills and mountains were erected, and the molten rocks poured out upon the surface of the earth.

§ 104. Such is the general hypothesis which one class of geologists have assumed concerning the formation of the globe. While another class, with equal confidence, and with numerous facts which favour their positions, have embraced the hypothesis that the matter of our globe was originally in a state of thin vapor, produced by intense heat,—and that, as this body of vapor gradually cooled down, it became more dense, and in due time, the surface became so cool that the matter began to consolidate and form a crust of rocks which slowly increased in thickness inwardly, while heat and moisture and frost and other agents acting on the external surface, caused a disintegration of the rocks as already stated; and when some thousands of years had passed away, and numerous layers of stratified rocks had been super-imposed upon the original crust, by the precipitation or deposition of matter held in aqueous solution, and derived from the disintegration of the primitive rocks, then the pent fires in the centre of the globe, became impatient of their confinement, and rose up in their wrath, and burst through their prison walls, now strengthened by the continual accumulations of hundreds of centuries, and thus, not only hills and mountains were formed, but islands and continents were lifted from the bottom of the ocean, and made dry land, and portions of the unstratified rocks or original crust were thrust up through the superincumbent layers, and thrown out upon the surface of the earth.

§ 105. I say there are many facts which greatly favor this Plutonian hypothesis, so much in vogue among geologists at the present day:—and yet I cannot feel convinced that, the objections against it are not more powerful than the facts in favor of it. Besides, I conceive that every fact which the advocates for this hypothesis adduce in its support, is perfectly compatible with the aqueous origin of the globe. But after all, it is of little importance to the argument which I have in view, whether the Plutonian or the Neptunian hypothesis is the true one: since, in either case, the general positions which I have advanced concerning the original forms and primitive combinations of matter are equally sustained. Nor indeed, is it of much importance to my argument, that any geological theory should be established.

§ 106. The great points I wish to prove are, first, that, the natural elements of matter, are very few in number and probably a single one;—secondly, that essentially the same matter is common to all material forms both of the inorganic and organic world, and therefore the essential difference between inorganic and organic forms of matter, is not in the matter itself, of which they are composed, but exclusively in the constitutional laws of aggregation and arrangement;—and thirdly, that, all the affinities, properties and laws of matter, established and brought into action during the formation, and up to the completion of the inorganic world, necessarily ended in inorganic aggregations and forms,—and beyond which, it was not possible for them to go.

§ 107. The first of these points, I have shown to be exceedingly probable—the second is unquestionably true: and the third admits not the shadow of a doubt.—To suppose that the action of inorganic affinities could terminate in organic arrangement, is to assume that, it is

possible for the same thing to be and not to be at the same time: and to say that organic affinities could grow out of any inorganic properties of matter, is equally contradictory and absurd.—If inorganic affinities or properties are exerted, inorganic results necessarily take place; and no combination of inorganic material causes, can possibly produce an organic effect. For, it is only by counteracting, and overcoming and suspending the inorganic affinities, and destroying the inorganic aggregations, that matter can be brought into organic arrangement, and established in the organic constitution. Hence it is always, and to all extent necessarily true, that, the inorganic affinities are directly opposed to the organic affinities; and therefore the latter could, in no possible way, spring from the former, nor from any results of the former.

§ 108. The atheistical notions concerning the origin of organic forms of matter, and of mind, are therefore, utterly unphilosophical, and entirely destitute of any foundation in scientific truth, and all attempts to account for vitality upon any principles appertaining to the physical or chemical properties of matter, must necessarily end in error and absurdity. To say that life is the result of peculiar organization of matter, is obviously and egregiously absurd: because we *know* that organization is always and necessarily the result of vital action, and therefore, excepting the first act of creation, vitality has always produced organization, and propagated and perpetuated itself in and through organized matter;—but has never been, and cannot, in the nature of things, ever be produced by organized matter not possessing life. And the notion that the organized matter of our world belongs to a state of things which has eternally existed, is entirely contradictory to all that we know of the nature of things.

§ 109. The inorganic world left to itself, with all its properties and powers in continual activity and perpetual operation, would necessarily have remained forever within the precincts of inorganic law and structure. The solitary ocean would have rolled on in its eternal flow and ebb of tides,—evaporation and clouds and rain,—lightnings and thunders and tempestuous winds, and raging hurricanes, and wintry storms,—and spring and summer skies and balmy airs, and bright and glorious sunshine, and sultry heat,—and congealing frost,—and night and day, would have succeeded in endless and unfertilizing rounds;—while on the surface of the solid and the liquid globe, and in its bosom, and deep within its bowels, the busy chemistry of inorganic nature, would have carried on its unceasing processes,—transmuting substances, and multiplying the varieties of forms and properties;—and kindling subterraneous fires to burst into volcanoes and to rend the globe with tremendous earthquakes, and heave the regularly concentric strata of its rocks into wild irregularity and disorder;—disturbing thus, the smooth rotundity of its surface, and producing lofty mountains and deep valleys,—and ploughing channels for the streams and rivers,—and scooping out new dwelling-places for the ocean:—but, not a tree nor plant nor blade of grass—nor any other organic form of matter, could possibly have been produced, by any, or all of the affinities and properties and powers of that lonely and lifeless world!

§ 110. Men, in the gloomy, or the sensual darkness of their minds, and in the temerity of indomitable pride, may speculate as they will, but sound philosophy and the truth of science, pause on the confines of the inorganic world, and are compelled to acknowledge the necessity of an intelligent and designing Omnipotence, to superinduce new laws of action and arrangement, and establish

new constitutions, by which matter shall be set free from the dominion of its more primitive affinities and lifted up above its former state of being, and *forced* into arrangements and structures and tissues and organs and systems, entirely different from any of its previous forms—by the action of affinities which cannot co-operate, nor efficiently co-exist in the least possible measure, with any of the inorganic affinities:—nay, indeed, which cannot act, but to resist and subdue the inorganic affinities,—which cannot erect their own peculiar superstructures, according to their own specific economy, without overcoming and demolishing at every step the affinities and structures of inorganic matter. (§ 86.)

§ 111. How then, could any primitive condition of inorganic matter, ever have produced—by any of its intrinsic properties or powers, a single blade of grass, or the simplest form of vegetable existence? It is not possible!—and such an opinion cannot be embraced, without a credulity which shuts its eyes against the light of science, and far exceeds the darkest superstitions of the human race.

LECTURE III.

All forms of matter composed of the same elements—Water the principal material from which vegetables are formed—The different vegetable substances produced from the same materials—Each, its fixed laws of constitution and relation—Animal bodies not produced by inorganic nor vegetable affinities—Essentially different—The constitutional economy of nature permanent—If man were cut off, matter could not reproduce him—Animal substances, how formed—The composition and properties of inorganic bodies—Organized bodies derive their existence from pre-existing organized bodies—Organic elements, how formed and arranged—Organic bodies consist of both solids and fluids—They take the type of the bodies that produce them—Life a forced state—Vitality resists gravitation—Resists the law of temperature.—Organic bodies return to inorganic forms of matter when life ceases—Hibernating animals, how preserved—Transmutation of substances—Life terminates in death—Mutability of organic forms—Properties common to all organized bodies—Difference between animal and vegetable bodies—Properties peculiar to animals—The use of chemistry to physiology—Vitality decomposes chemical elements—The nature of things depends not on their matter but their constitution—Constitutional nature and relations of each and every thing.

§ 112. It is then, as already stated, (§ 106.) by different aggregations of the same elementary atoms of which air and water, rocks and earth are formed, that vegetable substances and forms are produced.—Water is the principal material which enters into the vegetable structure. The atmosphere also affords a portion of the nutriment of vegetables; and light and heat are con-

cerned in the activity of vegetable life, and in vegetable growth, and qualities and forms. But all these substances, or forms of matter, on entering into the vegetable, organic structure, forego their inorganic forms and characters, and qualities and become vegetable, organic matter. The oxygen and hydrogen and carbon of inorganic chemistry, by virtue of new laws, new actions and new arrangements, become vegetable sap, and this, by various new arrangements, resulting from vital action, becomes solid wood and bark and leaf and blossom, and color and odor, and fruit and resin, and gum, &c. &c.—but while these compose the vegetable structure, and while vegetable life exerts its controlling energy, it cannot, with strictest propriety, be said, that, there is any such substance as oxygen, or hydrogen, or carbon within the vital domain:—these substances can only be detected as such, when they have been set free from the vegetable structure and arrangement and have returned again to the inorganic state.

§ 113. Yet notwithstanding vegetable substances have their fixed and peculiar laws of constitution, essentially different from those of inorganic arrangement, there is, nevertheless, such an exact adaptation of the constitutions of these different structures to each other, that the most determinate and fixed and important laws of relation exist between them.

§ 114. Here, again, if the vegetable and inorganic world be left to itself, it is not possible for any, nor for all of its material properties and powers, separately, or combined, to produce animal life, and structure, and organization, and its self-nourishing, and self-propagating economy. If inorganic affinities predominate, inorganic structure, necessarily results.—If vegetable organic affinities predominate, vegetable structure necessarily re-

sults.—They cannot possibly co-operate because they directly counteract each other:—and if it were possible for them to be simultaneously co-efficient, they could not act together, in the production of a third substance, differing from inorganic, and from vegetable organic structure, and of a higher order of nature than either;—but of necessity, from the nature of things, they would arrest each other, and remain in belligerent equilibrio. Besides, if it were possible for laws of action and constitution, to arise from any condition of inorganic and vegetable matter, by which animal life and structure and organization could be produced,—such laws, in order to accomplish such systematic results, must necessarily arise from the nature of things, and therefore, of necessity, must be as permanent in their existence and activity as the nature of things from which they spring. But such are the constitutional laws and relations of things, that they cannot essentially alter their natures without ceasing to exist; *for the nature of things depends not on the matter of which they are formed, but on the laws of constitution by which the matter is arranged.* (§ 106.)—Hence therefore, if it were possible for laws of action and constitution to arise from any condition of inorganic and vegetable matter, by which animal structure and organization and function could be produced, then of necessity, in the nature of things, such laws would still continue to exist and to produce their results; and living animal bodies would not depend on the vital power and economy, for their successive origination, but on the physical laws by which they were first produced. Yet we know that these things are not so:—and who with a sane mind, can believe, that, if every human being were, at this moment, destroyed from the face of the earth—matter, with all its inorganic and vegetable and animal

properties and powers, could, in millions of years—or even an eternity of time, reproduce the human species, or rise a hair's breadth above that order of being which now exists next on the scale to man!

§ 115. If animal matter were, in its ultimate elements, essentially different from vegetable and inorganic matter, then might we suppose, that, obeying laws peculiar to its nature, it entered into an arrangement peculiar to itself, without opposing or in any manner interfering with the inorganic and vegetable affinities:—but, when we know that animal matter resolved even to the experimental elements of chemistry, is in reality nothing but inorganic matter, common to all material forms and substances, we see that it is *not in any possible degree the nature of the matter, but the constitutional laws of arrangement, on which all the forms, and properties and peculiarities of material substances depend.* Hence therefore, of necessity, the laws of arrangement from which animal structure results, are not only opposed to the laws of inorganic and vegetable arrangement, but altogether of a higher order;—superinduced by a Power extrinsic from matter—by an Intelligence adequate to the great designs of nature, and by a Power competent for the fulfilment of its designs.

§ 116. A truly philosophic and scientific mind cannot indeed, ask for a more complete demonstration of the existence of an intelligent, omnipotent, and benevolent First Cause, than is afforded by an accurate knowledge of the laws of the various material structures, and forms, and modes of existence.

§ 117. By the controlling power of peculiar laws of action which overcome and suspend the inorganic affinities, and which also demolish the vegetable structure, matter is set free—or rather forced from its previous forms of aggregation, and compelled to take on the

arrangement, and enter into the structure, and compose the organs of living animal bodies; where it remains in reluctant vassalage, till, having fulfilled the purposes of the system, in subservience to the vital economy, it is regularly discharged from the vital domain—or until the vital power is wholly worn out or overcome and destroyed, when it returns again to the more primitive dominion of inorganic affinities and aggregations,—there to continue in the simpler and more permanent forms of inorganic matter, or be subject to its various changes, until perhaps, it is again forced into the comparatively brief endurance of vegetable or animal organic laws of life:—and so on, in the perpetual round of inorganic and vegetable and animal structure—matter takes its course, obedient to the various laws which comprise the several constitutions of those forms.

§ 118. Thus, from the same primordial atoms of which all vegetable and mineral substances are made, the living animal blood is also formed, simply by a different arrangement resulting from laws of action, which neither existed in any of the previous forms, nor sprung from any of the previous conditions or properties of matter;—but were instituted, and established in a permanent economy by a supreme, intelligent and designing Power. By a different arrangement of the matter composing this same living blood, the cellular substance of the animal is formed.—By a still different arrangement, the animal muscle is formed from the same blood,—and by a still different arrangement of the matter of the same blood, it formed the living animal nerve, which is the most remarkable for its peculiar properties and powers, of any known material structure. And thus every solid and every secreted fluid of the body is formed from the blood, by the peculiar arrangements of the atoms

of matter; and this is purely a result of vital power, acting, and accomplishing its ends in direct opposition to the chemical affinities of inorganic matter; and differing essentially in its nature and effects, from the vegetable organic economy.

§ 119. Notwithstanding therefore, all material bodies and substances are formed from essentially the same matter, by different arrangements of its primordial atoms, yet, by virtue of their different laws of constitution, organic and inorganic bodies and substances differ essentially from each other in their natures and forms and properties.

§ 120. Inorganic bodies, resulting from the more primitive affinities and simple aggregations of matter, (§ 106.) may, according to the statements of chemistry, consist of a single one of those substances which are called elements; or of a combination of two of them; or of four of them, in double binary compounds; or of six of them in triple binary compounds. They may also exist in the solid or liquid or gaseous forms; yet every inorganic body consists wholly, either of the solid, or liquid, or gaseous form of matter; and all its parts are alike in structure and properties, and may exist as well when separated into portions or broken into fragments, as when united in a single volume or mass. But whether solid, liquid or gaseous—whether composed of one or more of the chemical elements, the aggregations and arrangements of the atoms of matter in every substance, take place according to fixed constitutional laws, and in a regular and determinate manner; so that the intimate structure of each form of matter is always true to its own nature. Still however, the constitutional laws of aggregation in inorganic bodies do not define the shape nor determine the size of the general mass, and there-

fore, while their molecular arrangement is always strictly determinate and true to their nature, their general mass is either regular or irregular in shape, and large or small in size, according to circumstances, and the action of accidental causes; and, without in the least degree affecting their nature or properties:—and they are increased or diminished in size, or changed in shape, not by any internal economy of growth or decrement, but by the simple accretion of matter to, or attrition of it from the surface.

§ 121. Organized bodies, as we have seen, (§ 106.) do not result from the action of the more primitive affinities of matter, but are produced by a permanently established constitutional economy, the intrinsic forces of which, counteract and overcome those affinities, and bring the elementary atoms of matter into arrangements wholly different from those of inorganic substances: (§ 107.) and the forces of this economy do not act, as it were, unembodied and at large on the natural elements of matter, but their operations are always confined to living bodies, consisting of a system of organs, in and by which, they produce their peculiar effects, and transmute inorganic substances, into the substances and structures and organs of living, vegetable and animal bodies. All organized bodies therefore, are of necessity, produced only by the controlling power and action of the vital forces of living organized bodies:—or in other words, all organized bodies necessarily derive their existence from pre-existing organized bodies.

§ 122. In the peculiar processes by which the vital economy transforms the common matter of the inorganic world, into the organized matter of living bodies those simple forms of organic matter are produced which are called the organic elements, and which, according to

chemical analysis of dead vegetable and animal matter, are composed (generally speaking) in the vegetable of three, and in the animal of four of those substances, called the inorganic elements. But as the peculiar combinations and arrangements by which the organic elements are formed, can only be effected by the vital forces and actions of the living organs, so it is impossible by any other means or in any other manner to produce the organic elements.

§ 123. When the living body has elaborated its own elements from the various, and even very different materials on which its assimilating forces act, it distributes them to every part of the system by an internal economy peculiar to organized bodies, and, in the most regular and determinate manner, arranges them in its several structures and organs, and thus incorporates and identifies them with itself.

§ 124. These interesting processes and results require that organized bodies should be composed of both solids and fluids,—of solids differing in character and properties, arranged into organs, and these endowed with peculiar functional powers, and so associated as to form of the whole, a single system;—and of fluids contained in these organs, and holding such constitutional relations to the solids as that the existence, the nature and the properties of both, mutually and necessarily depend on each other.

§ 125. As the vital forces by which organized substances are produced, always and necessarily act in and by the organs of living bodies, (§ 121.) as intrinsic, constitutional properties or powers, so the operations and results of the vital economy are governed and determined by the organic constitution of the body in which it acts; and hence, all organized bodies not only derive their

existence from pre-existing organized bodies, but necessarily also take on the type of the bodies from which they spring, and are of the same internal and external structure and form; and when no disturbing causes modify the result of the general organic economy, they naturally come to the same size. And consequently, all organized bodies have, within a certain range, their specific proportions and shape and size; by which, as a general fact, they are not only distinguished from inorganic bodies, but specifically from each other.

§ 126. Not only the intimate structure, but the general conformation of parts and adjustment of proportions in organized bodies therefore, depend on the action of the vital forces and the general control of the vital economy; and life maintains its dominion over the organized mass, and preserves in all its parts an integrity of structure and of function, not only by counteracting and overcoming the inorganic affinities, in its processes of assimilation and organization, but by resisting the action of foreign powers and influences. For, while the chemical affinities of inorganic matter are more completely overcome and subdued by vitality within its own organic domain, chemical agents and the physical laws of nature, are continually exerting their influence on living bodies, causing an expenditure of vital power and tending to the destruction of the vital constitution, and the decomposition of the organized matter.

§ 127. From the commencement to the termination of the vital existence of organized bodies therefore, life maintains a continual conflict with opposing forces: and hence it has with beauty and propriety been said that, "life is a forced state,"—"a temporary victory over the causes which induce death."

§ 128. The common law of matter, which in our world,

causes all bodies to tend to the centre of the earth, acts equally on inorganic and organic bodies, and therefore, it is in direct opposition to this law, that vegetable vitality raises up the sap and constructs the vegetable form; and almost every function and action of animal bodies, is performed in opposition to the law of gravity.—The ascending fluids—the act of standing, and walking, and raising the hand &c. &c., are all vital performances, in opposition to the law of gravitation.

§ 129. Again, it is a common law in physics, that heat always seeks an equilibrium of temperature in contiguous bodies; that is, the hotter body always imparts its heat to the colder one in contact, until they are both of the same temperature: and this law appertains to all forms of matter,—inorganic and organic. Living bodies give off their heat to colder bodies in contact, the same as inorganic bodies, and but for their peculiar powers would soon become of the same temperature of contiguous bodies or the surrounding medium. By virtue of vitality however, they are enabled to maintain a temperature peculiar to themselves:—not by suspending or counter-acting the common law of heat, but by generating heat, according to the wants of the system; or by disposing of its excess in the formation of vapor. Even the lowest order of vegetable life, while in a state of activity, preserves a temperature peculiar to itself; and this is more remarkably the case with animal life: and especially in the higher orders of animal existence. The temperature of the human blood, for instance, is, in a healthy, robust man, about ninety-eight degrees; and it hardly varies two degrees from this point whether the temperature of the surrounding atmosphere be twenty degrees below zero or two hundred and sixty degrees above it:—but destroy vitality, and very soon the blood will be of the same temperature of the surrounding air.

§ 130. When heat acts on inorganic bodies, it raises their temperature by directly communicating itself or its quality or condition to them; but living animal bodies mostly or entirely resist this action of extrinsic heat, and their temperature is very little, if at all elevated by its direct communication to them as *heat*. When extrinsic heat therefore, serves to elevate in any degree the temperature of the living animal body, it does it in a twofold manner:—positively, and negatively.—Positively, by acting as a stimulus on the nervous system, and through that on the organs and vessels generally, and thus increasing vital and functional activity: and negatively by elevating the temperature of the surrounding medium, and thus preventing the radiation of intrinsic heat. Hence the more healthfully vigorous the vital power is in animal bodies, the better are they enabled to sustain the extremes of cold and heat.

§ 131. Organic arrangement of matter, being as we have seen (§ 106.) the result of vital forces which counteract and suspend the more primitive affinities of inorganic matter, depends entirely for its permanence, on the controlling power of vitality;—hence when organic arrangement is destroyed, it is always by the mastery of the inorganic affinities, asserting their prior claim to the organized matter: and consequently organic bodies when they cease to live, begin immediately to decay:—or in other words, their matter begins to return to the dominion of inorganic affinities and laws, and to enter into inorganic aggregations, and forms. But while vitality maintains its predominance, it resists the action of the principles of decay, and preserves the matter within its precincts, in its living organic nature and condition and powers.—Thus, vegetable and animal bodies being deprived of their vitality—unless artificially preserved—soon decay and pass into inorganic

arrangements and forms of matter; yet vegetable seeds and roots have been preserved by their vitality for thousands of years, with all their properties and powers so perfect, that even after a lapse of centuries, on being placed in a genial soil, they have vegetated and grown like the productions of the preceding year. And, in like manner, some of the animal creation, such as toads and frogs, have been preserved by their organic vitality, in a state of suspended animation, for hundreds and thousands of years; and on being set free from their incarceration in the bosom of solid rocks far beneath the surface of the earth, have awakened again from their living death, and exerted their powers of locomotion. But if the vitality of those bodies be extinct when they are first surrounded by the matter of the rock, and when that matter is in a fluid state,—or if they be surrounded when not in a state of hibernation or of suspended animation, and their vitality be destroyed, the fluid enters into the cavities of the bodies, and by its peculiar qualities, so acts upon the organized matter, that it foregoes its organic arrangement, and takes on the aggregation of the rock in which it is entombed, retaining only the general outlines of its animal form; and thus becomes an animal petrification. Vegetable substances are also, frequently petrified or transmuted in the same manner. “I have often seen amidst quantities of mineral ore brought into this city for manufacturing purposes,” says Mr. John Far, an extensive practical chemist of Philadelphia,—“pieces of wood, which at one end were partly carbonated, in the middle completely carbonated, and at the other end changed into sulphuret of iron, hard enough to strike fire with a flint.”

§ 132. Thus in every case, so long as vitality maintains its dominion over the matter which is forced into

its organic structure, it preserves that matter from the power of inorganic affinities, but when that conservating principle is destroyed, matter returns, as by a more deeply written instinct, to its more primitive and inorganic forms.

§ 133. Vitality, as I have already stated, (§ 108.) is not, in the least possible degree, the result of peculiar arrangements of matter,—but the peculiar arrangements of matter composing organic bodies, are always the results of vital action, and depend on vital power and vital action for their continuance: and hence living bodies not only derive their origin from pre-existing beings like themselves, (§ 125.) but also, in a perfect state, always possess faculties and powers, by which vitality perpetuates itself in connexion with organization, in the successive propagation of organized bodies. And hence also, (§ 126.) when that peculiar condition of organized bodies, on which the operations of the vital economy depend, is either violently destroyed or gradually worn out, the vital actions cease and life becomes extinct; and the individual existence of the body terminates in death, and the matter composing it, yields to the action of inorganic affinities, and dissolution and decay succeed. As a general law therefore, organic bodies, from their very nature and condition, are less permanent in their modes of existence than inorganic bodies are.

§ 134. See, in yonder peaceful and silent retirement, that gray, moss-covered rock, rendered hoary and venerable by the lapse of centuries, and deeply wrinkled in its ancient brow, by the waveless and noiseless, but swiftly gliding current of Time.—Beside it stands in full development and early vigor, a noble oak whose large and powerful branches stretch abroad, in bold defiance of the storms of heaven. In the shadow of that stately tree, and under the covert of that venerable rock, a little boy, full

of the health and buoyancy and vivacity of youth, is happy in the enjoyment of his childish play. To one who did not know the history of man, nor understand his nature, it would seem, as if that human form, in all its health and activity and power, might be as permanent in its existence as that tree and rock.

§ 135. Years pass away,—and lo! beside that rock, and in the shadow of that tree—leaning upon the handle of his scythe, in the full stature and sturdiness of manhood, he that *was* that boy, again appears.—Health, and athletic vigor, and energy of mind—and peacefulness of heart—bright prospects, and sustaining hopes, in all the fulness of life's prime, are his. He looks far abroad over his fertile fields, and in the dreamy sunshine of his soul, contemplates the prosperity and happiness of coming years.—But, in that bright, prospective vista of his thoughts, there comes no intimation to his mind, that, in those future years, so full of present hope, old age, with all its paralyzing and withering influences, will come upon him to take away his strength and elasticity,—and impair his senses, and—to him, throw over every thing in nature, the twilight mistiness, if not the melancholy of declining life.—But years pass on,—and there remains that rock, unaltered in its aspect and its form, save where perhaps, the violence of man, hath made a fracture on its insensible front,—and it may be, the inclemencies of heaven—humidity and frost, and the eternal and unebbing flow of time, have worn more deeply, the wrinkles of its brow:—and there that oak, in its full power, and stateliness, and verdant health, continues still beside that ancient rock;—no marks of time's destructiveness are on it;—save here and there, on the extremity of some long branch, a leafless and dry twig appears.—But lo, where but as yesterday that boy was seen, in the

spring-tide and joyfulness of youth, now stands an aged man, bowing in palsied feebleness upon his staff, and thinking how like a hurried dream his life has been.—He looks upon that rock and on that tree as the associates of his childhood; and they remind him of his youthful days, and bring back upon his chilled and aged heart, something of the warmer spirit of those years of childish cheerfulness and hope:—and it hardly seems reality to him, that such a change has passed upon him in the brief lapse of intervening time, which has stolen from him even as the oblivion of a single night! The rock, the tree—and all the face of nature, seem the same, as when in infancy he first beheld them:—but he is changed!—He *feels* that he is changed!—The bounding pulse—the elastic step—the buoyant spirit—they have passed away, and left him in the tottering feebleness of hoary-headed age!—A few more years pass on, and that old man is gathered to the dead, and his organic tenement returns to inorganic and insensible forms of matter:—and other generations come to make acquaintance with that rock and tree, and pass through life with all its hopes and fears, and joys and griefs, from childhood to old age, and die and moulder back to former dust!—Thus, in succession, generations rise and fall, till by and by, the years are numbered even of that tree;—and death begins to manifest itself, in the leafless and dry branches of its top;—and soon its verdure and its foliage wholly disappear, and the dead trunk and limbs stand hoary as the aged man!—and in a few more years, that tree is prostrate on its native earth and silently decays beside that solitary rock, which still remains but little changed in form and size and aspect, from what it was, even centuries before the tree first sprang from earth within the precincts of its shadow.

§ 136. Thus organic bodies begin their existence, and gradually grow up to maturity; and then decline and die, and decay, and pass into other forms of matter, in comparatively brief periods of time, while inorganic bodies more permanently exist—exempt from death, and from those internal changes and effects which impair and finally destroy the constitutional power of organic structure and arrangement.

§ 137. The properties already stated as peculiar to living organized bodies, are common to all vegetables and animals.—All living material beings—vegetable and animal, derive their origin from pre-existing bodies of the same kind; and possess the faculties of nutrition and reproduction, and alike terminate their peculiar modes of existence by death. Yet the animal kingdom is as distinct from the vegetable, as the latter is from the mineral kingdom:—and although animals partake of several physiological properties and powers and conditions, in common with vegetables, nevertheless, the constitutional laws of arrangement in animal matter, differ as essentially from those of vegetables, as the latter do from those of inorganic aggregation. Hence, animal structure is of an entirely different nature from that of vegetables, and possesses properties and powers peculiar to itself.

§ 138. The great fundamental endowments distinguishing animals from vegetables, are, sensibility—consciousness of being—volition and voluntary action or motion,—out of which grow a number of important and interesting faculties and peculiarities.

§ 139. According to the technical language of chemistry, vegetable matter, as a general statement, is formed by a peculiar combination of carbon, oxygen and hydrogen; while animal matter is formed by a peculiar com-

bination of nitrogen, oxygen, hydrogen and carbon. Several other simple substances are also said to enter into the composition of vegetable and animal bodies. But these statements are assumed rather for the convenience of theory than as being exact expressions of what is strictly true in the nature of things. The great fondness of modern chemists, to account for all the phenomena and results of vitality upon chemical principles, has too frequently led them to trespass on the prerogatives of life, and thus retard the progress of physiological science, by preventing that investigation of the vital forces and actions, which is necessary to a full ascertainment of the laws of life.—It should be ever remembered that, no organic substance can be separated from the vital control, and subjected to chemical experiment, without so essentially altering the character of the substance, as to render it impossible for the chemist to affirm, from the results of his experiments, with any degree of certainty, what is true or not true of the peculiar processes of the living organic system. It is therefore much more safe and philosophically accurate for chemists to say what inorganic forms or kinds of matter result from a chemical analysis of organic substances, than it is for them to state that organic substances are composed of such and such chemical elements or kinds of matter. We know, it is true, that all material bodies are composed of that common matter of the world which modern chemistry has distributed into more than fifty elements; and we know that in manufacturing its various organic substances out of that common matter, the vital economy employs more of some of those elements than of others. We also know that, some of those elements or forms of matter are much better adapted to the purposes of the living body than

others;—but we have no right to assume that, the vital forces possess no higher energies of analysis than are exerted by the chemical agents of the inorganic world; nor that, their principles of combination in any respect resemble those of inorganic chemistry:—on the contrary, we have reason to believe that vitality decomposes all those substances used in its economy, which chemists call elements; and that, in arranging its various organic substances and structures, its synthetical operations are very different from those of inorganic chemistry. It is therefore purely hypothetical to assert that oxygen and carbon and hydrogen and azote and other chemical elements, as such, combine, in the vital processes, to form the various substances and structures of the organic system. Nevertheless, it remains equally true, that the only essential differences between the various organic and inorganic forms of matter, consist in, and spring from the constitutional laws of arrangement which govern their component particles and *constitute the peculiar nature of each form*.

§ 140. The most interesting and important principles, therefore, which are presented to our consideration by these investigations, and which should make the deepest impression on every mind, are these—THE NATURE OF THINGS DEPENDS IN NO DEGREE, ON THE MATTER OF WHICH THEY ARE FORMED,—BUT ENTIRELY ON THE CONSTITUTIONAL LAWS OF ARRANGEMENT AND STRUCTURE, FROM WHICH THE PECULIAR FORMS AND PROPERTIES OF THINGS RESULT: and consequently, it is necessarily true,—not only that, each particular form of matter, has its specific laws of constitution, but also that, the constitution of each particular form, is so exactly adapted to the constitution of other forms of matter, in relation to which it exists, that the most definite and fixed

and inseparable laws of relation are established between all material forms; binding the universe together in one great and intimate community of interests, on principles as fixed and permanent and as unalterable as the nature of things.

§ 141. Thus, the proximate elements of nature were constituted with definite relations to each other:—and so on, as matter travelled down from its unimaginably subtil, and almost spiritual essence, (§ 87.) combining—it may be, its essence and its proximate elements in a thousand modes before it reached those forms which human science regards as simple substances,—each peculiar form of matter, throughout all the range, was constituted with fixed and permanent relations to all other forms:—and, continuing on in the progressive work of conformation, the same principle pervaded all material existence.

§ 142. Thus, water, has not only its fixed and necessary laws of constitution, but also its constitutional laws of relation to the gases of which it is formed;—and to every thing in the mineral kingdom formed from it: and thus, the vegetable sap has its own peculiar laws of constitution, and its fixed and precise constitutional laws of relation to water and the atmosphere, &c.;—and the woody matter, and bark and leaf and blossom and color and fragrance and fruit, &c. of vegetables, have all their particular laws of constitution, and their definite laws of relation to each other, and to the sap, and to the atmosphere, and to heat, and light, &c.:—and thus again, the animal blood, has its fixed laws of constitution, and its equally fixed and necessary laws of relation to the aliment from which it is formed, and to water, and the atmosphere, &c.;—and the bone, and cartilage, and muscle, and nerve, and all other forms of matter in the animal system, have their fixed and necessary laws of constitu-

tion, and their necessary laws of relation to each other, and to the blood from which they are formed.

§ 143. There are also many interesting laws of relation existing between the inorganic and vegetable and animal kingdoms, of a more general and obvious character, which spring from the constitutional nature of things. Thus the vegetable economy has its relations to the nature and qualities of the soil, and atmosphere—to climate and the seasons—to day and night—to heat and gravitation, &c. &c.; and the vegetable economy, to a great extent, elaborates from inorganic matter, the substances on which animals subsist;—and in turn, vegetables receive a portion of their nutriment from animal excretions. Carbonic acid gas which is thrown off in such immense quantities by animal respiration and perspiration, is, when received into the lungs without a mixture of atmospheric air, almost instantaneously destructive to animal life;—or, in other words, it is wholly unfitted to sustain animal respiration:—but the vegetable economy,—at least during the day—decomposes this gas and retains its carbon as vegetable nourishment, and sets free the oxygen, which is that peculiar property or constituent principle of the atmosphere that supports animal respiration.

§ 144. But these important and interesting relations are too numerous and in many instances too intricate to admit of a full exhibition at this time. I shall however, have occasion to speak of some of them which are most important to my subject, when I come to consider those particular points to which they more immediately belong. Suffice it now to say, that throughout the universe of created things, the laws of constitution and relation (§ 140.) compose the great permanent net-work in whose sustaining meshes all material forms and beings subsist.—And therefore, every thing in nature is bound to its general

condition, by laws innumerable, which cannot be violated with impunity.—And man—whether he will acknowledge it or not—is, in his constitution and relations, such that he cannot move nor breathe nor exercise volition without obeying or violating penal laws!

LECTURE IV.

All solids formed from fluids, in the mineral, vegetable and animal kingdom—Chemical analysis and physiology—Phosphate of lime in bones—Laws of vital combination unknown—From chyle and blood, solids formed—The department of the physiologist, what?—of the anatomist, what?—of the chemist, what?—How far chemistry can aid physiology—Chyle, its character—all the body formed from it—its properties nearly the same, whatever the food—The blood—all the substances of the body formed from it—Three general kinds of solids—Cellular, muscular, and nervous tissues—Globular form of the elementary filaments—The nature and properties of the three general tissues—These form all the organs—Their distribution and arrangement in the system—Natural order of development—Internal organs—External frame—Great divisions of the body—Arrangement of the serous membrane—its character—The bones—their number and arrangement—Cartilages, their situation, and uses—General skeleton—Original state of the bones—The structure and character of cartilages and ligaments—Properties of the muscle—distribution and functions—Nerves, their order, distribution and functions—Voluntary and involuntary muscles—Tendons—Number of muscles—Arrangement of voluntary and involuntary muscles—Muscle not reproduced.

§ 145. It is an interesting fact that, so far as human knowledge extends, all solid bodies are formed from fluids. In the mineral kingdom, the internal structure and general form of some solid masses indicate a previous state of fusion, or fluidity produced by heat or electricity; while

others strongly indicate, if they do not prove a state of previous solution, or aqueous fluidity, of their matter.

§ 146. In the vegetable kingdom we know that, all the solid as well as other substances in the plant or tree, are formed from the sap, which, in the radicles that absorb it from the earth, is apparently little else than pure water, and which is gradually changed into the vegetable nature, and determinately arranged in the vegetable structures, by the peculiar powers of the vegetable economy. And in the animal kingdom also, we know that all the solid, as well as other substances composing the living body, are formed from the thin watery fluid called chyle, which is elaborated from the digested food of the alimentary canal, and gradually converted into living blood, and diffused throughout the system, and arranged into solids and secreted into other fluids, by the peculiar energies of animal vitality.

§ 147. When the chyle and blood and bone and muscle and the various other solids and fluids of the system have been elaborated by the vital economy, chemists take these several substances and subject them to chemical experiment and analysis, and when they have resolved them to the simplest forms peculiar to the decomposition of animal matter, they denominate the substances thus obtained, the organic elements; and these again are resolved to the ultimate chemical elements, or purely inorganic forms of matter. And thus we are furnished with a chemical nomenclature of the elements that compose the living animal body. And learned physiologists, taking these results of the chemical analysis of dead animal matter, gravely attempt to account for most or all of the operations and effects of the living organic economy, on the principles of inorganic chemistry; and to teach us what chemical elements combine—and in what proportions, to form the several substances of the organic

system. But it must be perfectly obvious that most of their reasoning is purely hypothetical; for it assumes that the experimental elements of chemistry are the real elements of nature;—or, at any rate, that the vital forces cannot decompose them; and therefore, that the chemical decomposition of *dead* animal matter, demonstrates the vital composition of *living* animal matter. But, if any given number or proportions of the chemical elements, as such, combine to form any one animal substance, why is it not possible for the manufacturing powers of human science, with the same elements, to make any approach to the results of the vital processes? (§ 51.)

§ 148. The atheistical philosopher sneeringly tells us that, the human bone was not made by a God, as the ignorant superstitiously believe, but that it is composed of gelatin, phosphate of lime &c. and that these are formed by peculiar combinations of oxygen, hydrogen, carbon, azote, phosphorus, &c. But can such philosophers take these elements and compose the human bone?—or do they seriously believe that, there is any power or means in the material universe, by which the human bone can be composed, except the vital power and economy of the living animal system?—Whether phosphoric acid and lime, *as such*, enter into the vital composition of the animal bone or not, it is not possible for the atheistical philosopher to prove that they do;—and science affords him less evidence of the fact, than it does that, the peculiar economy, by which alone in nature, the animal bone is formed, was originated and established by an intelligent Creator. Nor would it be an easier matter for the chemical physiologist to demonstrate that the gelatin which so largely abounds in animal bodies is formed from the albumen of the blood by a chemical process, which abstracts from it a portion of its carbon, *as such*;—nor indeed, can it be proved that oxygen, or

carbon, or any other chemical element, *as such*, passes through the vital operations into the living results, retaining its peculiar nature and properties, or without entirely foregoing the nature and qualities which it possessed as an inorganic substance.

§ 149. All we know with certainty is, that when proper substances are received into the appropriate living and healthy organs of the animal system, they are, by powers and processes peculiar to that system, converted into chyme, chyle, and blood, and from the blood, into several distinctly different solids and fluids, possessing each its peculiar nature and properties;—the solids being so arranged as to form the several organs of the system, and the fluids being contained in those organs in such states and conditions as the welfare of the vital domain requires.

§ 150. To ascertain as fully and as accurately as possible, the properties and powers of the living solids, separately, and the functional powers and performances of the several organs formed by particular arrangements of these solids,—and the nature and purposes of the fluids,—and the general and particular laws and conditions which govern and affect the vital economy,—in short, to ascertain as far as possible, all the properties and powers and operations and effects of the living body, is the appropriate business of the physiologist. When the body is dead, the dissection and description of its several parts, organs, tissues, &c. is the appropriate business of the anatomist; and the analysis of the dead animal matter into proximate or ultimate elements, is appropriately and only the business of the chemist.

§ 151. Chemistry therefore, can tell us what forms of inorganic matter, result from a chemical analysis of dead animal matter; but she cannot tell us what forms combine to compose the living organ. She cannot inform us

a priori, whether mineral or vegetable or animal substances are best adapted to the alimentary wants of man: nor can she with any certainty direct us in the selection of even those substances which experience has proved to be nourishing to the human body.—She can decompose the atmosphere, but she cannot tell us which of its elements qualify it to support animal respiration.—If by reason of impaired functional power in the human stomach, foreign acids should be generated in that organ by the action of inorganic affinities, chemistry can inform us what will neutralize those acids, but she cannot tell us whether the alkalies which she prescribes, will not do more mischief to the living tissues of the organ, than the acids she seeks to neutralize; and therefore she cannot tell us whether her very remedy will not be a powerful means of perpetuating the evil she seeks to remove:—in short, she can in no respect, from her knowledge of the chemical elements, or their laws of combination in the living body, tell us what is salutary or baneful to the vital weal. All this, we learn only from the living body.

§ 152. While therefore all due honor is paid to the highly interesting and important science of chemistry, the science of physiology and of therapeutics, should be exceedingly cautious how they invoke her aid.—So far as chemistry can assist the physiologist in ascertaining and defining the external relations of the living body, she is useful to him; but more than this she cannot do, with that certainty which should inspire his confidence.

§ 153. The most simple form of the animalized matter composing the living body, is the chyle, which is elaborated from the digested food in the alimentary canal. This, when it first enters the radicles of those capillary tubes which conduct it onward towards the blood-vessels, is a very thin pearl-colored fluid, apparently homogene-

ous,—and, by chemical analysis, is almost wholly resolved into water. And, so far as *chemical* scrutiny has been able to discover, this fluid is almost precisely the same, whether elaborated from vegetable or animal food.* As it proceeds along the vitalizing tubes, it gradually becomes more and more albuminous and fibrinous; and with scarcely any appreciable difference in regard to these properties, whether the food be vegetable or animal; but in regard to vital properties and effects, differing very considerably, as we shall see hereafter. (§ 466.)

§ 154. When the chyle enters the blood-vessels it approaches very nearly in character, to the blood, which is itself *apparently* a very simple, homogeneous fluid, the chief constituents of which, are essentially albuminous; and of which, four fifths may be resolved to water by chemical decomposition.

§ 155. From the blood, the vital economy elaborates all the substances and forms of matter composing the animal body,—constructing with marvellous skill and wisdom—with reference to final causes—the blood-vessels, and the alimentary tube with the assemblage of organs associated with it for the purposes of nutrition, and the outer walls of the body, with its limbs and organs of external relation.

§ 156. The solid forms of organized matter thus inexplicably and wonderfully elaborated by the vital economy, from the fluid blood—consisting of membranes, and nerves and muscles, and tendons and ligaments and cartilages and bones, may all be reduced to three general kinds or substances—the gelatinous—the fibrinous and the albuminous; which, in the simplest language of modern physiology, are denominated the CELLULAR—the MUSCULAR and the NERVOUS TISSUES.

* See Note to § 465.

§ 157. Some eminent physiologists assure us that, the elementary structure of the animal tissue, is a delicate arrangement of minute globules; and that this is alike true of the cellular, muscular, and nervous tissues. (Fig. 1.)—Indeed, it is said, that the fluid as well as the solid parts, both of animals and plants, abound in these minute globules. In regard to the size of these globules, there is considerable difference of opinion. It has been asserted by some that, a globe of about the eight thousandth part of an inch in diameter, is the elementary organic molecule of which every solid of every animal body is formed. Others contend that the size of the molecules, differs in the different tissues, and even in different parts of the nervous system,—being, it is said, largest in the brain proper,—somewhat smaller in the little brain,—still smaller in the medulla oblongata,—smaller still in the spinal marrow, and smallest and most opaque of all in the nerves. These views may be correct; but in the present state of our knowledge on this subject, we cannot rely with entire confidence on the results of microscopic investigations.

Fig. 1.



§ 158. The gelatinous substance, in its various forms of proper cellular tissue—membranes—tendons—ligaments—cartilages, &c. is the most simple of all the animal solids, and the lowest in the scale of vitality and vital endowment. Its properties are cohesion, flexibility, elasticity; and in some of its forms, extensibility.—These properties are, none of them, peculiar to organized matter;—yet the elasticity of the cellular tissue, which is a very important power in the vital functions, is, probably, to a very considerable extent, a vital endowment; as it is much greater in the living body, than it is after life is extinct.

§ 159. The muscular tissue, composed of the fibrinous substance, is of a higher order of animalization and vital endowment than the cellular tissue. It possesses the two important vital properties of excitability and contractility. The former renders it capable of being acted on by stimulants, and the latter, of contracting or shortening its length, under the action of stimulants.

§ 160. It is impossible to say how far we can subject the animal tissues to our analytical investigations, without effecting an *essential* change in their nature; and therefore we cannot with entire certainty, affirm that the organized substance which we examine and on which we experiment, is precisely the same as when constituting a healthy portion of the living body. It is under this disadvantage and incertitude that we always necessarily labor when we attempt to ascertain the elementary character of any of the animal solids;—or even of any of the results of vital action:—and it is to a considerable degree, under this disadvantage that physiologists affirm that, the nervous tissue is essentially albuminous. But, as I have already stated, it is of comparatively little importance to the physiologist to know the chemical composition of the animal solids.—It mainly concerns him to know the vital properties and powers and functions of those solids when composed, and arranged into organs:—and in regard to these, there is little necessity for ignorance or uncertainty, on any important point.

§ 161. The nervous tissue is the highest order of organized matter: and is endowed with the most peculiar and wonderful, vital properties. In the descriptions of anatomy it is said to consist of two, apparently distinct substances.—The one is sometimes called cineritious, because it is generally the color of ashes,—sometimes, cortical, because it lies on the surface of the brain like the

bark of a tree, and sometimes, from its apparent consistence, it is called pulpy. It is said to appear under a powerful microscope, to be principally composed of a congeries of blood-vessels. But the truth is, the real structure and character of this substance, is little understood. Some consider it a kind of matrix or ganglion by which the real nervous substance is produced and re-enforced; while others believe it to be the more refined and exalted part of the nervous substance, in which the sensorial power more specially resides. All this however, is nothing but conjecture.

§ 162. The other substance, from its resemblance to marrow, is called medullary,—or in contra-distinction to the cineritious, it is called the white substance, and more recently it has been called the fibrous substance, in contra-distinction to the pulpy. It is of firmer consistence than the pulpy, and the matter of which it is composed, has in our own day, been ascertained to be arranged in the form of minute and delicate fibres.

§ 163. In every portion of the nervous system, which constitutes a distinct nervous apparatus, the pulpy substance is found associated with the medullary or fibrous, in some of its parts. Sometimes investing the surface as in the case of the brain; and sometimes situated more internally, as in the spinal marrow.

§ 164. The peculiar vital powers of the nervous tissue are two,—the nervous and the sensorial.

To the nervous belong—the vital properties concerned in the functions of digestion, absorption, respiration, circulation, secretion, organization or the processes of structure, and the production of animal heat. The transmission of external impressions to the centre of perception, and of the stimulus of volition to the voluntary muscles, have also been classed among the nervous properties, but

it is questionable whether the former of these two powers or faculties does not more strictly belong to the sensorial power of the nervous system.

§ 165. To the sensorial power belong consciousness—sensation—the perception of external impressions and internal affections, reflection, volition and other faculties called intellectual.

§ 166. Sensibility is generally considered the fundamental sensorial power; yet the brain, which is regarded as the more special seat and centre of the sensorial power, is, in its own proper substance, entirely destitute of sensibility or the power of sensation, in the ordinary meaning of the word. Animal sensibility in the physiological signification of the term, is the power of sensation in the living nervous tissue, and sensation is an affection of the living tissue, of which the centre of perception is not only conscious, but always refers it to some particular locality. Animal sensation therefore not only makes the mind conscious of a body, but of particular parts of the body. This is not necessarily true of the sensorial power. We may gaze on an interesting and absorbing scene or sink into a deep reverie, and lose all consciousness of a body, and be only conscious of a mental existence. We *think*, it is true;—and we are conscious of our thoughts, but we are not conscious of the organic machinery of our thoughts,—and still less do we refer our thoughts as sensations to any particular part, or organ of the brain. At such times we are not even conscious of a brain nor of a head nor any thing of a corporeal nature. To say therefore, that sensibility is the fundamental sensorial power, is to give the term sensation a very broad signification, and to confound things, between which in the common understanding there are very important differences.

§ 167. These three general tissues—the cellular, muscular and nervous, together with the more solid matter of the bones, compose all the organs and parts of the animal system; and, in entering into the texture of the several organs, each tissue carries with it, and retains during life and health, its own peculiar vital properties, and these together, become the fundamental principles of functional power in the organs.

§ 168. The cellular tissue constitutes a kind of reticulated frame-work to the whole body;—(fig. 2.) giving shape and proportion to

Fig. 2.



each particular organ, and connexion to all; and entering so intimately and extensively into every part, that if the other substances were entirely abstracted, the cellular tissue would perfectly preserve, not only the general outlines of the body, but the definition and proportions of each particular organ and part.

§ 169. Every bone partakes largely of this substance in a spongy or cellular arrangement, the interstices of which are filled with a fluid, separated from the blood, which becomes hard and gives the peculiar solidity to the texture. Some of the bones are united by this substance in the form of elastic cartilage, or fibro-cartilage, as the vertebræ of the back—the ribs to the sternum, &c. and the articulating surfaces of the bones are also sheathed with cartilage: and the joints are strongly secured, and different bones bound together by another form of the same substance, called ligament. This last form is likewise expanded into a fibrous membrane which surrounds every bone in the osseous system, and also surrounds the cartilages and forms sheaths for the tendons.

§ 170. Besides this distribution to the bones, carti-

lages and tendons, the cellular tissue forms sheaths for every muscle and for every fibre of which each muscle consists, and principally composes the tendons, and tendonous expansions which connect the muscles with the bones.—Every fibre and fasciculus and cord of the nervous system, is also separately enveloped in a delicate

Fig. 3.



sheath of cellular tissue; (fig. 3.) and the brain and spinal marrow are wrapped in a membra-

neous texture of the same substance.

§ 171. The different tissues in their arrangement in the texture of the several vessels and viscera of the body, are connected together by the cellular tissue; and in fact, this substance principally composes the solid part of all the vessels and viscera of the system: and finally, each individual organ is enveloped, and every internal surface is lined, and the external surface of the body is covered with membranes composed of this substance.

§ 172. With very limited exception, if any, the vital contractility of the muscular tissue, is the only element of positive motion in the living animal body. All voluntary motion, and most, if not all, involuntary motion depend on this vital property of the muscle. Hence the muscular tissue is distributed where motion is required. The bones are incapable of motion within themselves, and consequently no muscular tissue enters into their texture. But they serve as levers of voluntary motion, and therefore the muscles of voluntary motion are connected with them, and attached to them, in such a manner as that the contraction of the several different muscles, produces the various motions required. The windpipe, meatpipe, stomach, and intestines are also furnished with muscular tissue. The heart is principally muscular,

and the diaphragm is mostly composed of muscular tissue. Several other internal organs are supplied with this tissue. The arteries and veins are said, by some anatomists, to be destitute of it, and yet it is very certain that they possess the power of contractility.

§ 173. The nerves, being the more peculiar and immediate instruments of vitality, preside over the functions of the vital economy; and consequently they are distributed to every part of the system where a vital function is performed;—accompanying the blood-vessels in all their ramifications, and being most intimately associated with every muscular fibre and filament.

§ 174. In the order of nature, the blood-vessels with their appropriate and presiding nerves, are first produced, and these immediately commence the structure of the alimentary tube with its accompanying organs,—furnishing each, with its due supply of cellular, muscular, and nervous tissue, according to its particular office in the system, and the powers required for the performance of its special function. At first, the several internal organs, are, in a measure, so many distinct and independent formations or systems, which become more and more connected as their development advances, and finally, they become so intimately associated as to form of the whole assemblage, a single system. In the mean time, a wonderfully constructed tabernacle is in preparation for them. The spinal column, and the arching ribs, with their investments of muscle and membrane, form the hollow trunk, which encloses, supports and protects them. The head, and then the upper extremities, and the lower extremities, and the organs of special sense, and the external skin with its appendages of hair and nails, follow in their order.

§ 175. For the better protection of the organs, and

for other important purposes, the cavity of the body is divided by the diaphragm into two apartments. (Fig. 40.) The upper one is called the thorax, and the lower one, the abdomen. The thoracic cavity, extending from the neck to the lower extremity of the breast-bone in front, and somewhat lower at the sides and back, contains the lungs and heart and a portion of the large blood-vessels, and the meatpipe. The abdominal cavity contains the liver, stomach, intestinal canal, pancreas, spleen, kidneys, &c. (Figs. 4. and 31.)

Fig. 4.



V. Large blood-vessels.

R L. Right lung.

L L. Left lung.

H. Heart.

D D. Diaphragm.

Liv. Liver turned up.

Stm. Stomach.

G. Large blood-vessel in the abdomen.

I I I. Intestines.

§ 176. For the still farther security of the several parts, and the general well being of the whole, a peculiar texture of the cellular substance, called the serous mem-

brane, completely lines both cavities of the body, and then facing back upon itself, it is extended and folded in such a manner, as to envelope each organ separately and in a measure, to insulate and confine it to its proper place. Thus, in the thorax or chest, the serous membrane—here called the pleura—besides lining the cavity throughout, including the upper surface of the diaphragm, faces back upon itself, and surrounds each lung, and passes double across the chest from the breast-bone to the back-bone, forming a septum or double partition between the lungs, called the mediastinum, and thereby completely encloses each lung in a sack by itself,—the one on the right and the other on the left side of the thorax. The two laminae or sheets of membrane which form the middle partition are separated at the lower part of the chest to receive the heart between them. This organ is also surrounded by its own peculiar membrane called the pericardium. The serous membrane which lines the inner surface of the abdomen and envelops each organ of that cavity, has the general name of peritoneum; but its particular parts are designated by terms significant of the organs invested. Thus, the part which embraces the intestinal tube, and holds its convolutions in their relative position, is called the mesentery, mesocolon, &c. (Fig. 5. See also, fig. 35.)

Fig. 5.

A P, the dotted line representing the serous membrane lining the walls of the abdominal cavity.

M, the mesentery.

I, the intestine, surrounded by the serous membrane which forms its peritoneal coat.

S, the spine.



§ 177. In regard to the particular anatomy and physiology of the serous membrane there is much difference

of opinion. Some describe it, as being abundantly supplied with nerves and vessels, both being colorless, and the latter containing a colorless fluid, and performing the office of exhalants and absorbants;—and this they consider fully proved by the fact that the serous membrane is capable of a high degree of inflammation and morbid sensibility; as in pleurisy, peritonitis, &c. On the other hand it is asserted with equal confidence, that this membrane is entirely destitute of both vessels and nerves; and that fluids pass through it by infiltration or imbibition. Those who entertain this opinion, of course, deny that this membrane can be the seat of inflammation and morbid sensibility. They contend that the inflammatory diseases, attributed to the serous membrane, have their seat in the subjacent tissue, and that such is the thinness and transparency of the serous membrane, that the inflamed aspect is seen through it, and gives it the appearance of being itself inflamed.

§ 178. Be the truth as it may, in regard to this disputed point, it is of very little importance as a matter of practical knowledge. In a healthy state, at least, the serous membrane has no animal sensibility. Its surface, external to the organs, but internal to itself, is exceedingly smooth, and is continually lubricated by a fluid which is either exhaled from its vessels or passes through it by infiltration from the subjacent vessels. By these means, contiguous organs are enabled to move with ease upon each other, and the adhesion of contacting parts, is prevented. On the side of the membrane next to the organs and the parts which it lines, it is everywhere surrounded or covered with a spongy cellular substance, which contains more or less of adipose or fatty matter, according to the condition of the body. In fleshy people, large quantities of fat accumulate in many parts of this tissue. (§ 508.)

§ 179. The bones which compose the solid framework of the body, and serve to give it shape and firmness, and to form its cavities, and its organs of prehension and locomotion, are of various forms and sizes. Some of them are hollow, and their cavities are lined by a cellular membrane which contains an unctuous substance called marrow, the use of which is not certainly known. The whole number of bones in the body, is two hundred and fifty-six; of which, fifty-six belong to the trunk, sixty-six to the head, sixty-eight to the upper and sixty-six to the lower extremities.

§ 180. Of the bones of the trunk, twenty-nine, and in some instances, thirty are employed in the construction of the spinal column or backbone. Twenty-four of these are called the true vertebræ, and the other five are called the false vertebræ, or the sacrum and coccygis; these last being concerned also with the hip bones in the formation of the pelvis or basin at the bottom of the trunk, and constituting the base on which the vertebral column rests. Of the true vertebræ, seven belong to the neck, twelve to the back and five to the loins; and are accordingly distinguished by the terms cervical, dorsal and lumbar vertebræ, from the latin *cervix*, neck, *dorsum*, back, and *lumbus*, loins. These bones have somewhat the shape of a ring, with a rounded body in front and several projections from the arch behind; one running directly back which is called the spine, and two

Fig. 6.



b b, c c, processes of the arch.
f, foramen or opening.

Fig 7.

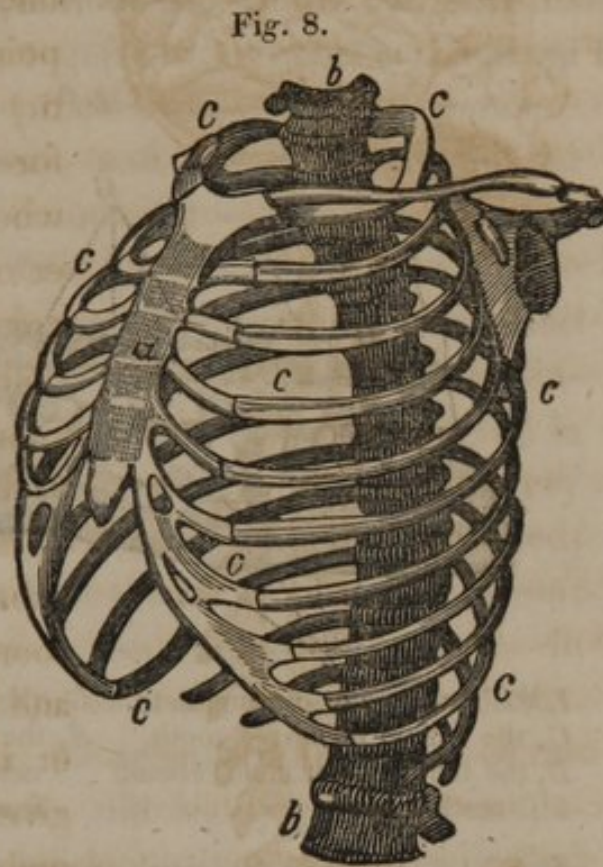


running obliquely backward with which the ribs form one of their two posterior points of attachment. (Fig. 6.) The vertebræ are therefore so constructed, that, when arranged in their proper order, they form both a column of support to the body, and a canal for the spinal marrow. Between all of these bones, is interposed an elastic fibro-cartilaginous substance, which, with surrounding ligaments, unites and binds them to each other in such a manner as to give to the column considerable flexibility and elasticity, and at the same time, secure to it, all the supporting power of a solid bone. In the most natural, easy and graceful position of the body the spinal column is not erect, but waved or curved; and such is its elasticity, caused by the intervertebral cartilages that an individual is sometimes about an inch taller when he rises in the morning than when he retires at night. (Fig. 7.)

Bones of the head and spinal column, divided on the middle line so as to show—
a, the brain; *b*, the little brain; *g*, the medulla oblongata; *c*, *d*, the spinal marrow.

§ 181. Attached to each side of the twelve dorsal vertebræ, are twelve ribs, which, together with the breast-bone, form the cavity of the chest.

Most of the ribs have a double attachment behind;—one to the body of vertebræ, and one to the transverse process or oblique projection. — They droop as they proceed forward, so that their anterior extremities are considerably lower in their natural position, than their posterior. The upper seven, — called the true ribs, are



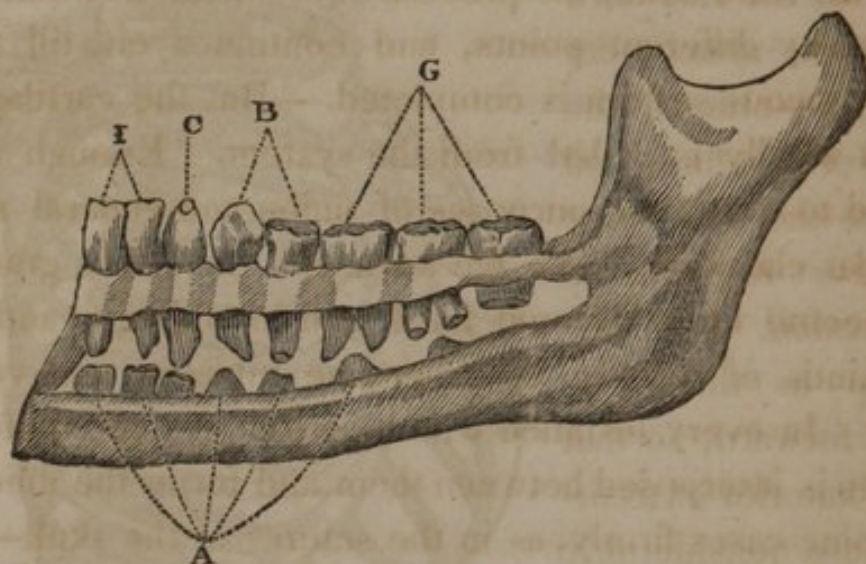
b b, the spinal column. *c c c*, the ribs.

united directly to the sternum or breast-bone by cartilages. Of the remaining five, called the false ribs, three are joined in front to each other and to the superior ribs by curved cartilages, and the two lowest are not in any way connected with the sternum, and are called floating ribs. (Fig. 8.)

§ 182. Of the sixty-six bones which belong to the head, seven enter into the formation of the strong globe or skull which contains the brain, and which rests upon the top of the spinal column and receives the head of the spinal marrow through a large foramen or opening at its base. Four small bones constitute a part of the auditory apparatus of each ear. The rest, beside the thirty-two teeth, are employed in forming the upper and

lower jaws, the cheeks, the nose, the palate, &c. There are in each jaw sixteen teeth;—of which there are on each side two front, one corner, and five cheek teeth. Fig. 9.

Fig. 9.



I, the incisores or cutting teeth. *G*, the molar or large cheek teeth.
C, the cuspid or corner tooth. *A*, the rudiments of the permanent teeth before they emerge from the jaw.
B, the bicuspid or small cheek teeth.

§ 183. To the upper extremities belong, on each side; the shoulder blade, the collar-bone, the long bone of the upper arm—the two bones of the fore arm,—the eight small bones of the wrist,—the five of the body of the hand—the fourteen of the fingers and thumb, and the small appendage to the thumb joint.

§ 184. To the lower extremities belong, on each side, the hip bone—the long bone of the upper leg or thigh, the two bones of the lower leg, with the patella or kneecap,—the seven small bones of the ankle and heel,—the five bones of the instep or body of the foot,—the fourteen of the toes, and the small appendage to the great toe joint.

§ 185. At first,—before the solidity of the bony structure is required by the condition of the animal, the place of the bones is entirely occupied by cartilages having the

precise shape of the bones to which they afterwards give place, except that they are, none of them, hollow.—As the time approaches when the condition and functions of the organized system will require the support and protection of the solid bone, the process of ossification commences at many different points, and continues on, till the whole osseous system is completed.—But the cartilages are not wholly expelled from the system. Enough are retained to serve the purposes of union and general and particular elasticity. As life advances the bones gradually become more dry and hard, and in old age, and in some kinds of disease, they become vitreous and very brittle. In every instance where two bones are united, cartilage is interposed between them and forms the union:—in some cases firmly, as in the sutures of the skull—in other cases admitting flexion, as in the back bone and ribs. In all the moveable joints, the articulating surfaces of the bone are covered with dense, and highly polished cartilages, which are continually lubricated by a glairy fluid called synovia:—by which means the joints are enabled to act with great ease and little friction.—Cartilage is also employed separately from the bones in forming some of the cavities: as the larynx, windpipe, part of the nose, &c.—All the cartilages, except the articular, are, like the bones, surrounded by a fibrous membrane called the perichondrium. Anatomists differ much in regard to the vascular and nervous endowments of the cartilages. There is no reason to believe however, that they have any other nerves than those which belong to the texture of the vessels concerned in their growth and nutrition: (§ 230.) and accordingly, they have in health, no animal sensibility: (§ 294.) nor, in health, do their vessels contain any red blood.—In early life, the cartilages are very soft:—they gradually become drier and harder; and in old

age, they lose much of their elasticity and become brittle; and some of them ossified, or converted into bone;—especially those of the fixed joints as the sutures of the skull.

§ 186. By this interposition of cartilaginous substance between the bones many advantages are gained. Besides the flexibility of the spinal column and the yielding of the ribs and other bones, friction is prevented in the joints: and a general elasticity is imparted to the frame; greatly assisting in running and jumping, &c., and to a very considerable extent, protecting us from injury by breaking the force of blows, falls, &c.

§ 187. The ligaments consist of an assemblage of strong fibres composed of the cellular tissue. They are employed in connecting the articular ends of the bones and cartilages; and in securing the moveable joints, in such a manner as to prevent displacement, and at the same time, to allow of all necessary motion. Some of them are situated within the joint like a central cord or pivot;—some surround it like a hood, and contain the lubricating, synovial fluid;—and some are in the form of bands at the side.

§ 188. The ligaments bind the lower jaw to the temporal bones, the head to the neck,—extend the whole length of the back-bone in powerful bands, both on the outer surface and within the spinal canal—and from one spinous process to another:—and bind the ribs to the vertebræ and to the transverse processes behind, and to the breast-bone in front, and this to the collar-bone, and this to the first rib and shoulder blade and this last, to the bone of the upper arm at the shoulder joint, and this, to the two bones of the fore arm at the elbow joint, and these, to the bones of the wrist, and these to each other and to those of the hand, and these last to each other and those of the

fingers and thumb. In the same manner also, they bind the bones of the pelvis together, and the hip bones to the thigh bone, and this, to the two bones of the leg and knee pan, —and so on, to the ankle and foot and toes, as in the upper

Fig. 10.

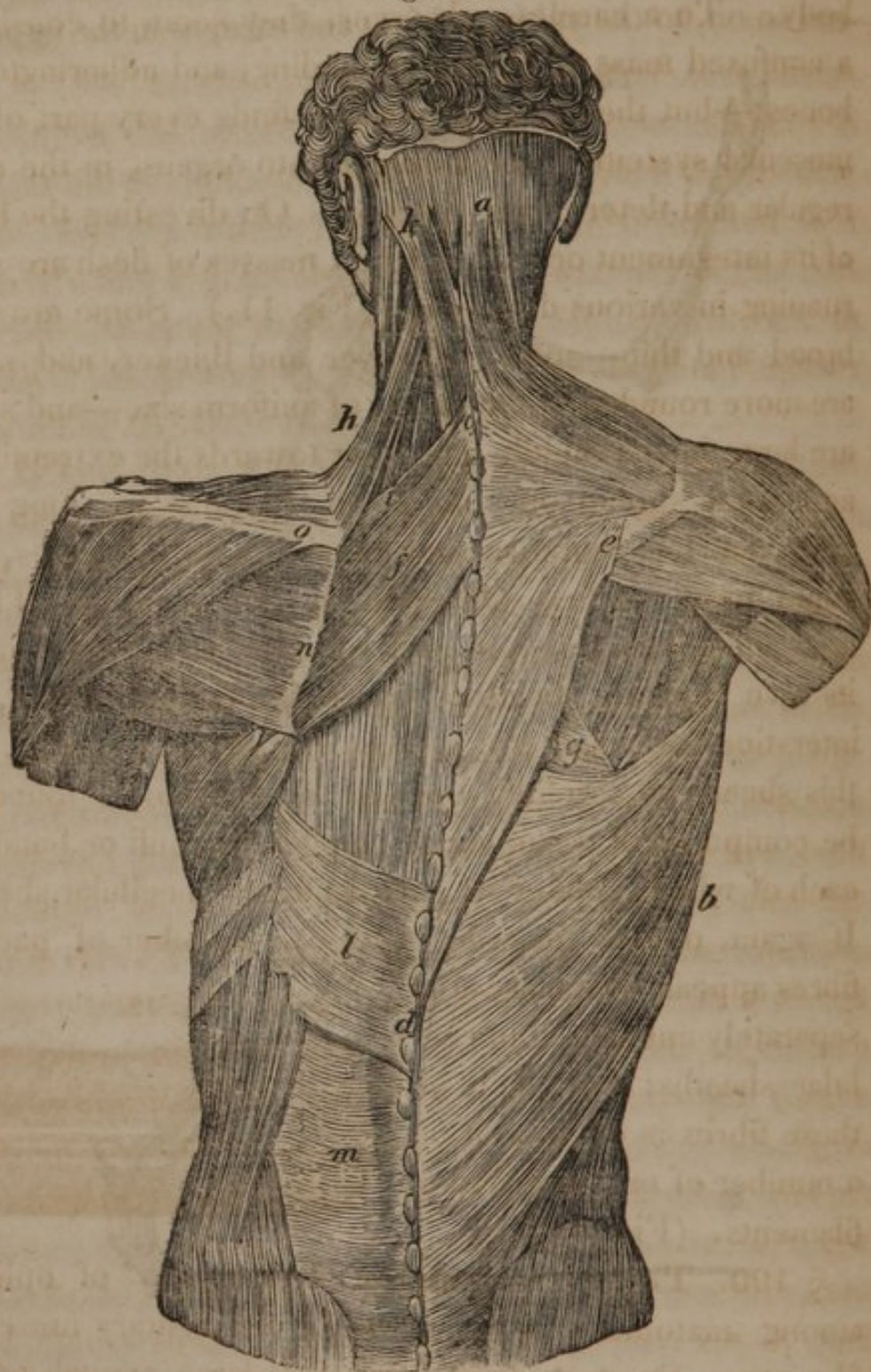


The skeleton.

extremities.—And thus, the whole osseous system is united and bound together in the most powerful and admirable manner; so as to possess in a wonderful degree, mobility and firmness. (Fig. 10.) The ligaments like

the cartilages, are, in health, destitute of animal sensibility, and like them, are more soft and yielding in early

Fig. 11.



The trunk divested of the skin showing the muscles, *a*, *b*, *c*, &c.

life and become more dry and rigid and inflexible in old age.

§ 189. The muscles, commonly called the flesh, which clothe the bones with symmetry and comeliness, constitute a considerable part of the whole bulk of the body. To a careless observer, they seem to consist of a confused mass of flesh, surrounding, and adhering to the bones:—but the scientific inquirer finds every part of the muscular system, to be arranged into organs, in the most regular and determinate manner. On divesting the body of its integument or skin, distinct masses of flesh are seen running in various directions. (Fig. 11.) Some are very broad and thin—some, narrower and thicker, and some are more rounded.—Some are of uniform size—and some are large in the middle and taper towards the extremities, and some spread out like a fan.—Some are long and some short.—Some running parallel with the bones, and some more or less obliquely or transversely. These are called muscles; and each of them is surrounded by its own separate sheath of gauze-like cellular tissue, the interstices of which are repositories of fatty matter. If this sheath be carefully opened the muscle is found to be composed of a number of parallel fasciculi or bundles, each of which, is likewise surrounded by a cellular sheath. If again, one of these be opened, a number of parallel fibres appear, which are also separately enveloped in cellular sheaths: and each of these fibres is composed of a number of minute parallel filaments. (Fig. 12.)

Fig. 12.



§ 190. There is the utmost discrepancy of opinion among anatomists, in regard to the elementary muscular filament.—Some asserting that it is large enough to be perceived by the unassisted eye, and others, that it is too small to be discerned under the most powerful microscope.

—Some say that it is hollow, and others affirm that it is solid.—Some assure us that it is a continuous, uniform thread, and others contend that it is a delicate arrangement of minute globules, surrounded by a soft, albuminous substance, and appearing like a string of fine beads. But these points are of little importance to us. If we can fully ascertain the vital properties and functional powers of the muscle, and know on what these depend and how they are affected by those causes which are under our control, we possess essentially all the knowledge in regard to the nature and structure of the muscular filament, that can be of practical utility to the world.

§ 191. I have said (§ 159.) that the vital properties of the muscle are 1st, susceptibility or a peculiar kind of *organic* sensibility to stimulants. 2d, contractility, or the power to shorten its length under stimulation.—These are generally regarded as a *single* property, or power, and denominated muscular irritability. But they are obviously different powers. The one is a power to *receive* an impression, and the other, a power to *act* under that impression, and they are both vital endowments of the muscle. In regard to muscular contraction physiologists do not agree. Some say that, when the muscle contracts, its fibres are bent in a waved direction, and have a knotted appearance: and others assert that there is a longitudinal condensation of the substance.—Some think the volume of the muscle is increased by the act of contraction, and some assure us that it is not. But it is enough for us to know that, the living healthy muscle, in all its forms and situations, has vital contractility, which is essentially the same, and subject to the same laws, in all the parts and distributions and appropriations of the muscular system. Some physiologists contend that, the muscle also possesses the

power of active extension:—but the opinion is not w supported, and is probably incorrect.

§ 192. The vital properties of the muscle, are rapidly exhausted by action, and therefore, it is requisite that they should be continually replenished or sustained.—This depends most directly and immediately on the arterial blood: and consequently it is necessary that the muscle be constantly and freely supplied with that fluid. Accordingly, numerous and capacious arteries are distributed to the muscles, penetrating them in every direction and extending in countless ramifications to the smallest filaments, and conveying to the muscular system a very large supply of blood, to replenish its exhausted energies and to nourish its substance. Veins everywhere accompany the arteries to receive their unappropriated blood and conduct it back to the heart; and thus, a continual stream of fresh arterial blood is poured through all the muscular tissue.

§ 193. The nerves which are distributed to the muscles of voluntary motion are of three kinds. 1. Those that accompany, and belong to the blood-vessels, and preside over their functions. These are only concerned in maintaining those conditions and in producing those changes in the blood which are necessary to the welfare of the muscle. 2. Those that convey to the muscle the stimulus of the WILL. These are supplied in great numbers, and they divide and subdivide till they are too small to be detected. These only act to stimulate and exhaust the muscle. 3. The nerves of animal sensibility, that convey to the animal centre of perception, those impressions by which the mind is informed of the action and conditions of the muscles, and of external tact, &c. These are furnished in small numbers, and hence the muscles possess but little animal sensibil-

ity. None of these three kinds of nerves, can be concerned, in imparting directly and immediately to the muscle, its peculiar vital properties. Those properties therefore, belong to the intrinsic vitality of the muscle: and this vitality can only be maintained by constant supplies of arterial blood, in an appropriate condition; and this, as a permanent fact, requires the presence and integrity of all the nerves described. A degree of muscular contractility however, remains, sometimes a full hour after the extinction of animal life.

§ 194. The muscles of the body are divided into two classes, in the descriptions of anatomy. Those of voluntary motion, and those of involuntary motion. The former are also called the muscles of animal life, and the latter, the muscles of vegetative or organic life. The muscles of voluntary motion or of animal life, generally invest the bones, and are mostly, on the outer parts of the body, and greatly abound in the limbs. The muscles of involuntary motion belong to the vascular system and the digestive and respiratory apparatus.—Some of the muscles of voluntary motion attach themselves immediately to the bones; but most of them terminate their two extremities in a fibrous arrangement of cellular tissue, called tendon, and by these tendons, or tendonous expansions, are attached to the bones. (Fig. 13.) Some anatomists

Fig. 13.



A biceps muscle, or muscle having two tendons at one end and one at the other.

suppose the tendons are formed by the continuation and condensation of the cellular sheaths which surround the muscular fibres. (§ 168.)

§ 195. In their texture and properties, the tendons differ very little from the ligaments. They are composed of small white fibres closely united to each other, and are surrounded by sheaths, lined by a membrane which secretes for them a lubricating fluid. They possess little elasticity or extensibility,—have no animal sensibility, and but few vessels, and these not discernible in an ordinary state. Like the cartilages and ligaments they are more soft and elastic in early life than at a later period, and become dry and rigid in old age.

§ 196. The tendons being attached to the muscles at one end, adhere at the other, to the periostium or membrane which surrounds the bones and which unites them to the bones; and thus they become the media through which the muscles act on the bones. Some of them are very long and extend to parts considerably removed from the muscles, as in the upper and lower extremities. This arrangement secures many mechanical advantages to the system, and very greatly contributes to the symmetry and beauty of the body,—by accumulating muscles into large masses in some places, and withdrawing them from others, and thereby giving the beautifully curved outlines of the trunk and limbs, and the small ankles, wrists, &c. The tendons are usually found only at the extremities of the muscles, but they are sometimes inserted in the middle, dividing the body of the muscle into two or more parts, as in the under jaw, the neck, diaphragm, &c. The end of the muscle which is attached to the most fixed point is called its head or origin—the fleshy mass is the body, and the end attached to the moveable point, is its termination. Some of the muscles are only attached to the bones at one extremity; and some, being circular, have no direct attachment to the bones. Both of these last

named kinds, are found in the face—surrounding the mouth, &c.

§ 197. As the muscles have only the power to produce motion by their contraction, they are so arranged as to act as antagonists to each other,—some *displacing* a part and some *replacing* it:—some flexing or bending a limb, and some extending it: and therefore, they are termed the abductor and adductor—the flexor and the extensor muscles. The flexor muscles are considered to be generally more powerful than the extensors, and hence when the WILL ceases to act, as in sound sleep, and death, the body and limbs are partially flexed or bent.

§ 198. According to Meckel, “there are in the normal or proper state of the body, two hundred and thirty-eight different muscles, six of which are composed of two parts which unite on the median line, and two hundred and thirty-two are in pairs; so that the whole number of voluntary muscles is four hundred and seventy.” These are so arranged and adjusted, as to position and connexion, that by the contraction of the different pairs or individual muscles all the voluntary motions of the trunk, of the head, of the upper and of the lower limbs are performed. The function of respiration which, to a certain extent, is both voluntary and involuntary, also employs some of these muscles.

§ 199. The muscles of involuntary motion, are much more simple in their external form than those of animal life; and except in the heart, they have no appearance of tendons. Their fasciculi, fibres and filaments are not distinct and parallel to each other but continually interlace, and consequently are much shorter than the fibres of the voluntary muscles. Their fibres are arranged in several superimposed layers and these layers are most generally transverse or oblique; and form rings round the cavities

which they circumscribe. The circular fibres or rings are nearest each other at the orifices of the cavities, and are stronger than the longitudinal or oblique fibres. The involuntary muscles do not antagonize, or act in opposition to each other; but they either act in concert, or so as not to counteract each other; as their office is to diminish the cavities in length and caliber; both of which, may be done simultaneously. Some of the muscles or fibres however act alternately or successively as in the heart and intestines. The involuntary muscles are even more abundantly supplied with vessels than those of animal life.

§ 200. The muscles of the body, like the cartilages, ligaments, tendons, and other forms of the cellular tissue, are at first, very soft, and gradually become more consistent and powerful; and in old age, they gradually become more and more dry and rigid.

§ 201. The muscular substance when once destroyed is never reproduced; but when the muscles are wounded, with, or without a loss of their substance, the breach is healed and the parts united by a peculiar arrangement of cellular tissue, which is wholly insensible to the action of stimulants.

LECTURE V.

The nervous system the most important portion of the body—The more immediate organism of vitality—Through the nerves vitality acts on all the other tissues and substances of the body—Nervous system subject of great interest—Difficult to study—Physiological properties common to all living bodies—Vegetables and animals:—Different degrees of consciousness and voluntary motion in different orders of animals—Organs of sensation and locomotion—of internal and external relation—their functions—Animal bodies have two classes of functions—of nutrition—of voluntary motion—How far are they dependent on a nervous system?—Have vegetables nerves?—Brain and spinal marrow, &c. supposed to be the nervous system of man—errors of the opinion—Natural law and order of development—Human bodies without a brain and spinal marrow—Errors from experiments on living animals—Brain and spinal marrow passive in the development of the body—Must be some other system of nerves—Nerves of organic life, their development, distributions, arrangements and functions—General order of the development of the several parts of the body—Nerves of organic life preside over all the function of development, and nutrition, &c.—Composition of the ganglions—Cerebro-spinal system—its order of development—distribution—arrangement and functions.

§ 202. THE nervous system is, in many respects, the most interesting and important portion of the human body. It is the more immediate organism of vitality, and the vital operations, and the intellectual manifestations: and hence it has been said that, the nervous system constitutes the man; and that, the bones and muscles, and the whole assemblage of internal organs with their various functions, are only intended to sustain and serve the nervous system.

§ 203. Vitality, however, is by no means peculiar to the nerves; but, in various degrees, it pervades all the tissues of the living body; and the blood is a living fluid: and the chyle also, especially in its more advanced stage of assimilation, possesses a measure of vitality. Nevertheless, the nerves are more highly endowed with vital properties and powers, than any other substance of the body: and they are,—in the animal kingdom at least,—most evidently and immediately, the instruments of vitality in all the operations of its wonderful economy.

§ 204. By the vital power of the nerves, the properties of the other tissues are called into exercise, and the functions of all the organs are performed. The food is digested into chyme, and thence into chyle, and thence into blood; and the blood is transformed into the various solids and fluids of the system, and at the same time the temperature of the body is regulated. (§ 173.)

§ 205. By virtue of the vital endowments of the nerves, we perceive our internal wants, and external condition, and relations;—and act upon the muscles, and through them upon the bones, in our voluntary motions. And by virtue of the peculiar and mysterious endowments of the nervous substance, we think and reason and feel and act, as intellectual and moral beings. (§ 530.)

§ 206. It is not surprising therefore, that the nervous system of man has ever been the subject of peculiar interest to the anatomist and physiologist;—nor, when all the difficulties of the subject are considered, is it wonderful that a great diversity of opinion and theory, has always obtained in regard to it. Among those difficulties, the almost impossibility of carrying our inquiries within the vital domain without disturbing the vital economy to such an extent as to throw the utmost uncertainty over the results of our investigations, is by no means the

least. Yet it is to be apprehended that, this difficulty has been too much disregarded by those who have boldly, and even rudely, invaded the precincts of life. Had those physiologists who have experimented so freely and extensively on living animals, always duly appreciated the force of sympathies in those bodies while under their experiments, they would probably have been saved from many erroneous conclusions; or, at least, would have asserted them with less confidence.

§ 207. I have said that all living bodies possess those faculties by which their nourishment and growth are effected—their temperature regulated, &c. (§ 137.) The vegetable seed, by virtue of its own vitality, excited to action by a genial soil and other appropriate circumstances, puts forth its little roots into the earth, and absorbs foreign matter and converts it into the substances and textures of its own organism; and thus, an economy is established by which the trunk and branches and twigs, and leaves of the giant oak, are gradually and fully developed, and all the vital operations of the tree maintained, until the condition on which the continuance of the vital action depends, is worn out, or destroyed, and then death ensues.

§ 208. Drawing its nourishment from the earth into which its roots penetrate, and from the atmosphere which surrounds it, and, in none of its final causes, requiring a voluntary change of place nor the performance of any other voluntary function, the tree, by nature, is fixed to the spot from which it springs, unconscious of its being, and without any organs of external perception and of voluntary motion. And, so far as those vital operations are considered by which chyme and chyle and blood are produced and the blood circulated throughout the system, and the body, in all its parts nourished, and

growth and development effected, and the temperature regulated, and all the other functions of organic life sustained, the animal differs but little from the vegetable; and in health, is equally destitute of animal consciousness.

§ 209. In the lowest orders of animal existence, the Zoophytes approach so near, in all respects, to vegetables, that naturalists long doubted whether they belong to the animal or vegetable kingdom. They are but dimly conscious of their being; and are nourished by means which scarcely demand faculties superior to those with which the vegetable is endowed. But the higher orders of animals being nourished by substances which are not only external, but separated from them, require both a perception of the internal wants of the system, and the faculties by which they can perceive, and approach to, and seize the external substances by which those wants are supplied. Hence organs of sensation and of locomotion and prehension, subject to voluntary control, are necessary as organs of external relation;—the primary office of which, is to perceive and procure the materials by which the body is nourished and place them within the reach of those organs of nutrition, by which the whole system is built up and sustained in all its powers and operations; and also, to perceive and avoid, or withdraw from those causes or means, by which, the vital interests and the comfort of the body, may be disturbed and destroyed:—and, having fulfilled these duties, the organs of external relation, have no other immediate concern with the internal organic functions, except so far as their own welfare and integrity, depend on the general welfare and integrity of the whole system. And this is true of all the higher, as well as of the lower classes of animals.

§ 210. There are therefore, in organized bodies, two

general classes of functions, and a corresponding organization. The primary class, consists of all those functions which are concerned in the nourishment, growth, temperature and general sustenance of the body, as an organized being. The secondary class, consists of those functions which minister to the wants of the primary class, and are established with reference to the relations between those internal wants and the external supplies, and to the general external relations of the body. The functions of the primary class, I have said, are common to all organized bodies, both animal and vegetable; but those of the secondary class are peculiar to animals.

§ 211. The important question then is; do the functions which are common to all organized bodies depend on a system of nerves, or are they performed independently of any nervous system?

§ 212. It is a disputed point among physiologists, whether there is a system of nerves in vegetables or not. Some have asserted that, they have been able clearly to discover a simple system of nerves in vegetable bodies; while others declare that, there is nothing in vegetables which approaches to the nature and character of a nerve. —That there is nothing in vegetable bodies which approaches to the nature and character of an *animal* nerve, cannot be doubted: for the whole molecular arrangement and organization, and all the vital operations and results of the vegetable, differ essentially from those of the animal; and therefore it is impossible that the organic structure and properties of any of the vegetable tissues should be the same as those of the animal. Nevertheless it may be, and probably is true, that there is a tissue in vegetable bodies which in functional character corresponds with the nervous tissue of animals, as nearly as the functions of vegetables and animals,

correspond in their processes and results. Be this as it may however, it is entirely certain, that as the vegetable derives its nourishment from the earth, into which its roots penetrate, and has none of those external relations which require voluntary motion, so it has none of those organs of external relation, which are concerned in perception, locomotion, and prehension; and has nothing which in structure or properties or functional character, corresponds with the cerebo-spinal system of nerves in animals.

§ 213. The nervous system of the human body has generally been considered as consisting of the brain and spinal marrow with their numerous cords, branches, and twigs, dispersed over the whole organized system: and these have been supposed to preside over all the varied operations and manifestations of life.

§ 214. Some anatomists and physiologists have contended that, the brain is the original point of nervous development, from which spring, as from a grand root, the spinal trunk and all the branches and twigs of the nervous system: and these, have considered the brain as the great centre of nervous, as well as sensorial power; or as a kind of vital galvanic battery, which continually generates nervous energy, and distributes it through nervous conductors, to the several organs of the body, according to their functional necessities;—presiding in this manner, alike, over all the vital functions of the system. The opinion which has been more generally entertained, however, is that, the spinal marrow is the grand, original centre or axis of the nervous system, and that the brain and all the nervous cords, branches and twigs of the body, spring from, and in a measure, depend upon it. But if either of these opinions were correct, then it would necessarily be true that, in the original

development of the body, the brain or spinal marrow would be the first-formed portion of the system, and come earliest to maturity of form, size and consistency, and of functional character and power. For it is a law of nature, in the development of organized bodies, that those parts are first produced and brought forward to a functional capacity, which are most essential to the earliest operations of the vital economy. But we know that, in the establishment of an economy, by which an animal body is to be developed, the first thing necessary, is a presiding centre:—the next thing is the blood-vessels, over the functions of which, that centre presides, and by which the development of all the other parts of the system, is effected. If therefore, the brain or spinal marrow were the presiding centre of vital operations, in the formative processes of the body, then it would necessarily follow that, all the branches belonging to this centre, would issue from it, and go out with the blood-vessels, to preside over their functions, in the formation of other parts, and to enter into the texture of parts thus constructed. But this is not true. So far is the brain or spinal marrow from being the first-formed portion of the system, that all the other parts of the body are formed, and considerably developed, while the brain and spinal marrow are yet in a fluid state, not more consistent than the white of an egg, and utterly incapable of exercising any functional power:—and so far are the nervous branches, which have been supposed to issue from the spinal marrow, from investing the blood-vessels and presiding over their functions, that they are almost totally distributed to the voluntary muscles and to the outer surface of the body.

§ 215. But nature has not left us in the dark, on any of these points. Where her normal operations have

failed to instruct us, her abnormal exploits have afforded complete demonstration. Children have been born without a vestige of a brain or spinal marrow: and I have known one instance, in which all the parts of the body, were regularly and healthfully developed, except that there was no brain, nor spinal marrow, nor even a trace of a spinal canal; the vertebræ being entirely solid. Such children of course, cannot live, after respiration becomes necessary; because respiration, though strictly speaking, an involuntary function, is yet, for important reasons, which will be hereafter stated, immediately connected with the nerves and muscles of animal life; or of voluntary motion.

§ 216. Some distinguished physiologists, because they could not tear the brain and spinal marrow from the living animal, without arresting the functions of organic life, have insisted that those organs preside over these functions. But such physiologists might have been saved from their error, had they considered that the assemblage of organs constituting the animal system, is more of a republic or a confederation than an absolute monarchy; and that the powers of that system are so delicately adjusted and so nicely balanced, that, any considerable violence done to a particular part—and especially an important part—is necessarily felt as a disturbing cause, over the whole system; and often to such a degree as to destroy the balance of power, and arrest all the functions of life, without, by any means, proving that the injured part is the centre of life, or that, it is the organ which presides over the vital functions of the system. Ten thousand such experiments therefore, are of no weight against the single fact that nature has produced a body in all other respects perfect, but destitute of a brain and spinal marrow; and yet evincing by every appearance, that its

organic life had continued till respiration became necessary.

§ 217. It follows of necessity then, that, the brain and spinal marrow with their nervous appendages, stand rather in the relation of an effect than of a cause, to the formative and conservative operations and economy of the animal system: and we must therefore conclude either, that this economy in animals as in vegetables, has no apparent nervous system which presides over its functions,—or that, in animals there is an apparatus, or system of nerves which, so far as the internal interests of the economy are concerned, is independent of, and in the order of nature, prior to the brain and spinal marrow.

Nerves of Organic Life.

§ 218. In the human body, such a system is readily found. In the very midst of those parts which are known to be the first produced in the natural order of development, is a mass of nervous matter which, in composition, very nearly resembles the brain. (Fig. 14. *a*.) This mass which may with propriety be considered as a species of brain, is undoubtedly the very first formed portion of the human body, and is the grand centre which presides over all the functions concerned in the development and growth of the body, and the general function of nutrition, during life.

§ 219. In close connexion with this central mass, and scarcely second to it in order of time, is produced the rudiment of a heart with a few of its principal blood-vessels, which gradually extend and enlarge and become more complex. Into all of these, as a part of their texture, enter branches from the central mass, which thenceforward through life, presides, in a general manner, over all



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the functions of the sanguiferous system. Accompanying the blood-vessels, numerous other branches of nerves go out from the central brain, in different directions, and form other, smaller, and subordinate brains, (fig. 14. *o*) which become the more special centres of development, and of perception and action, to individual organs, or particular apparatuses of organs. These subordinate brains or special centres, in their turn, give off numerous branches, some of which enter into the texture of the blood-vessels formed for, and appropriated to their service, in the construction of their particular organs; others are distributed to the contractile tissue or muscles of those organs, as the conductors of the stimulus of involuntary motion; others also, are distributed to the organs as the nerves of organic sensibility, or the conductors of impressions made upon the organs, to their special centres: and finally, in order to establish a more intimate connexion between the different special centres, and bring them all into a more direct relation to each other, and to the common centre, large cords run directly from one centre to another; and numerous branches go from each centre, to interlace and unite and form plexuses with branches coming from several other special centres, and from the great common centre. (Fig. 14. *v*)

§ 220. The alimentary canal and the other organs associated with it in the general function of nutrition, being earlier in the order of development than the other parts of the body, (§ 174.) the special centres concerned in their development, and which are the more special centres of perception and action to them during life, are the first of the subordinate brains which the formative economy produces. (Fig. 14. *o*.) At an early stage of the general development however, numerous fibres rise on each side of the central mass, which form a pair of large

cords, called the trisplanchnic nerves, that pass upwards—the one on the right and the other on the left side of the middle line (fig. 14. *s*) and give rise to an elongated mass or an uninterrupted series of small brains, which gradually separate in a longitudinal direction, and draw farther and farther apart,—keeping up their connexion with each other by intermediate branches, till they form a connected range of about fifteen little brains, on each side, extending, in the fully developed body, along the spinal column from the bottom of the thoracic cavity, to the top of the neck. (Fig. 14. *x*.) In the progress of these developments, the trisplanchnic nerves (*s*) become divided in their upper portions into from three, to seven or more branches, which terminate in as many of the little brains in the two ranges. (*x*.) Eight or nine more of these little brains are arranged in a similar manner, on each side, in the abdominal cavity, so as to form, in the completely developed body, a continued series, on each side of the back bone, from the base of the cranium to the inferior extremity of the spinal column. Each of these little brains in the two ranges, sends out numerous branches;—some of which serve as I have said, to unite the several little centres successively to each other:—others plunge into the muscles:—others (fig. 14. *z*) form connexions with the nerves and muscles of animal life, of which I shall speak hereafter. But the largest number of branches, from each of these little brains in the two ranges, go to interlace, and form numerous plexuses (*v*) with branches from others of the same, and of the opposite side, and from those more deeply seated among the viscera; (*o*) and from the great central mass itself. (*a*.) From these plexuses again, numerous branches are given off to the different organs, entering intimately into their texture. And all the branches and twigs of this system of nerves,

as they proceed along their course to their destination, cross and unite and divide and interlace, so as to form of the whole system, one extended net, the meshes of which, become smaller and smaller, as the nerves become more and more attenuated and approach to their inconceivably minute termination in the organs.

§ 221. The two ranges of little brains, with their connecting cords and other branches which I have just described, are generally supposed by physiologists, to be designed to bring all the parts associated in the functions of organic life, into a closer union, and to establish between them, the most intimate and powerful sympathy: and therefore, they are commonly called the great sympathetic nerves. Some writers however, include under this denomination, all the nerves of organic life. But I apprehend there has been much error of opinion on this point. Whatever may be the anatomical knowledge concerning these nerves, which they have derived from written descriptions, or from dissections, most writers on anatomy and physiology, still speak of the brain or spinal marrow, as the grand centre of nervous power, which presides, in a general manner, over all the functions of organic life, as well as those of animal or phrenic life; and therefore, they do not seem to perceive any other use for the nerves of organic life, than merely to serve the purposes of sympathetic association.

§ 222. That the two series of little brains with their connecting cords, &c. do serve to bring all the organs with which they are connected, into a closer union as a single system, and to establish between them a more powerful bond of sympathy, is, I think, undoubtedly true, and I consider it equally certain, that they perform other and very important offices.

§ 223. Considering this whole system of nerves as that

which presides over all the vital functions in the development and sustenance of the body, and the other special centres already described, (*o*) as being more immediately concerned in the development of the organs employed in the general function of nutrition, does it not legitimately follow from physiological analogy, as well as from anatomical arrangement, that the two series which extend the whole length of the spinal column, (*x*) are more immediately concerned in the development of the spinal nerves, and of the cerebro-spinal system generally, and perhaps also, of all the other parts pertaining to the trunk and extremities?

§ 224. It seems to be a general law of the vital economy, in the development of organized bodies, that, where any new, subordinate centre of action is established, for the construction of any particular organ or apparatus, a subordinate brain or nervous ganglion is produced. Every anatomist knows that, one of these ganglions, is found on each spinal nerve, near its connexion with the spinal marrow, (fig. 17. *d*) and several of them are found in the brain; and according to some, the spinal marrow itself is but a continued series of them. Now then, if the spinal nerves are not developed from, and by the spinal marrow, as the original centre of action in the formative process of the vital economy, but are developed independently of it, by functions over which the nerves of organic life preside, (§ 223.) where does the development of these nerves commence, if not at the ganglions near the spinal marrow?—and is this not rendered still more probable by the fact, that, each of these ganglions is directly connected by large cords, (fig. 14. *z*) with one of the little brains of organic life, which form the extended series along the two anterior sides of the spine (*x*) and one of which, lies very near to each of the ganglions

of the spinal nerves, with which it is connected? There may be insuperable objections to this view of the subject, but if there are, I confess I have not yet been able to discern them.

§ 225. In brief review of this whole system of nerves we perceive then, that, by means of cords which unite the several little brains (fig. 14. *o*, *x*) to the great central mass, (*a*) and those which unite the little brains to each other, and the numerous branches from the different centres, which interweave and form plexuses, (*v*) in every part of the two great cavities of the body, all of these centres are brought into the most intimate and powerful union, as a single nervous system: and then, by means of the numerous branches, distributed from each of these centres to its particular organ or organs,—and the numerous branches which pass from the several plexuses, to different organs, the whole assemblage of organs concerned in the functions of organic life, is, as it were, woven into one grand web of nervous tissue, and brought into a general and powerful communion of sympathy. (Fig. 14.)

§ 226. I have said (§ 218.) that in composition, the central mass nearly resembles the proper animal brain. This is also true of all the special centres or subordinate brains. Like the proper animal brain, they are all composed of the white, and the gray nervous substance, surrounded by a vascular membrane, analogous to the pia-mater of that organ, (§ 272.) and an external envelope of dense cellular tissue. They have the closest resemblance to, and indeed, seem to be but repetitions of the brain of some of the lower animals: and they undoubtedly perform many of the functions of a brain;—acting as centres, to all necessary extent, in their appropriate spheres, both in receiving impressions from, and in dispensing nervous powers to their special domains.—In the nomen-

clature of anatomy however, these bodies are termed ganglions or knots. The great central mass which is situated at the roots of the diaphragm, in the upper and back part of the abdominal cavity, or nearly back of the pit of the stomach, consists of several parts. 1. Two semicircular bodies about an inch long and half an inch broad, lying one on the right, and the other on the left side of the backbone. These are called the SEMILUNAR GANGLIONS. (Fig. 14. *a.*) They are probably at first, united in a single mass, and afterwards partially separated to accommodate themselves to the duplicate arrangement of the human body. (§ 281.) They however remain closely connected by many large branches which pass from one to the other, and form what is called the SOLAR PLEXUS. (*e.*) These two semilunar ganglions, united by the solar plexus, constitute the grand centre of all the ganglions and plexuses of organic life. Surrounding this great centre, as I have said, (§ 219.) and united to it by cords and plexuses, are the numerous special centres which subordinately preside over particular functions. These, and the ganglions that range along the two sides of the back bone, are much smaller than the semilunar ganglions, and are of an irregular ovate form.

§ 227. The ganglions of organic life, are, in the descriptions of anatomy, divided into two orders, called the central and the peripheral or limiting ganglions. The central (*o*) are those which are more deeply seated among the viscera, and which are supposed to preside generally, and specially, over the functions concerned in nourishing and sustaining the body:—the peripheral or limiting (*x*) are those which form the two ranges, on the sides of the spinal column, and have been supposed to be more particularly appropriated to the general sympathies of the internal system, and are accordingly called the sympathetic nerves. (§ 221.)

§ 228. This general system of nerves, consisting of a common centre, and many special, and subordinate centres, with their numerous cords, branches, plexuses, &c. (§ 225.) is sometimes called the ganglionic system. And, because these nerves preside over all the functions common to animals and vegetables, (§ 208.) and, in health, without the consciousness of the animal, they are also called the nerves of vegetative life:—but they are most commonly denominated **THE NERVES OF ORGANIC LIFE**, in contra-distinction to the brain and spinal marrow with their branches, &c. which are called **THE NERVES OF ANIMAL LIFE**. (Fig. 16.)

§ 229. There seems however, to be little propriety in calling these latter, the nerves of *animal life*, for they have no independent *life* peculiar to themselves, nor are they directly and immediately concerned in maintaining the common life of the body. Their functions may be entirely suspended for a considerable time and still the common vitality of the body be preserved. Andrew Wallace, a surviving Revolutionary veteran, now over a hundred years old* and remarkably vigorous and active, was struck down by lightning, while tending a cannon on the fourth of July, soon after the close of the American Revolution, and lay seventeen days in a state of suspended consciousness or animation: and a youth now living in Philadelphia once lay twenty-eight days in this condition. But a single moment's entire suspension of the functions of the nerves of organic life, would be a death from which there can be no resuscitation. The brain and spinal marrow with their nervous appendages are also, sometimes called the phrenic nerves, as being the more immediate and exclusive organs and instruments of the mind: but they are perhaps most commonly and

* Wallace has since died at the age of one hundred and five years.

most properly called THE CEREBRO-SPINAL SYSTEM OF NERVES.

§ 230. Of the nerves of organic life, there are three orders, (§ 219.) First, according to nature, those that enter into the texture of the blood-vessels, and other portions of the vascular system, and go with them in all their ramifications, to their most minute terminations in the different tissues, and preside over all their functions of absorption, circulation, secretion, structure, &c. &c.;—second, those that go to the contractile tissue, or muscles of involuntary motion, in the texture of the organs, and convey to them, the stimulus of motion:—third, those that are distributed to the organs, as the nerves of organic sensation, and which convey to the special centres, and, if necessary, to the common centre, (§ 226.) the impressions, made upon the organs. The cords which serve to connect the special centres to the common centre, and to each other, are probably composed of filaments of all these three orders.

§ 231. In this distribution of the nerves of organic life, each organ is supplied according to the nature of its function, and its relative importance in the system. The heart, which in its rudimental state, lies near the great ganglionic centre, (§ 219.) and which, with its vessels, is first employed in constructing the alimentary canal and the organs associated with it in the general function of nutrition, (§ 220.) is gradually removed, farther and farther from the centre, as the several parts of the system become developed and enlarged. Composed of tissues peculiarly susceptible to the action of their appropriate stimuli, and simply employed under vital control, as a mechanical power, to circulate the blood, without effecting any changes in it, the heart seems to require, and to possess but few nerves. All this is likewise true of the

large blood-vessels. But in the capillary system, or minute extremities of the vessels, where all the important changes take place, the nerves much more largely abound. But as I shall have occasion to speak of the tissues of the several organs, when I come to treat of their functions, it is not necessary to enter into particular details here. I will therefore, at present, only observe that, of all the organs of the body, the stomach is the most remarkable for its nervous endowments, and for its functional and sympathetic relations. Lying near the great ganglionic centre, it receives a large supply of nerves directly from that source, and is thereby brought into the closest sympathetic union with the common centre of organic life, and through it, with all the organs and parts in its domain. By the arrangement and distributions of plexuses also, the stomach is brought into very direct relations with the heart, liver, lungs, and all the other organs.

The Cerebro-Spinal Nerves.

§ 232. I have already stated (§ 214.) that it has been a prevailing opinion among physiologists, that the spinal marrow is the grand nervous axis or original centre, from which spring all the other parts of the whole nervous system belonging to the human body, and that it, in a general manner, presides over all the formative processes in the organic development, and all the functions of the vital economy, during life. But we have seen (§ 215.) that, these opinions cannot be true, because the brain and spinal marrow are among the last-formed portions of the body, and every other part of the body may be, and actually has been completely developed without them.

§ 233. The cerebro-spinal nerves therefore, together with the muscles of voluntary motion, and the bones of

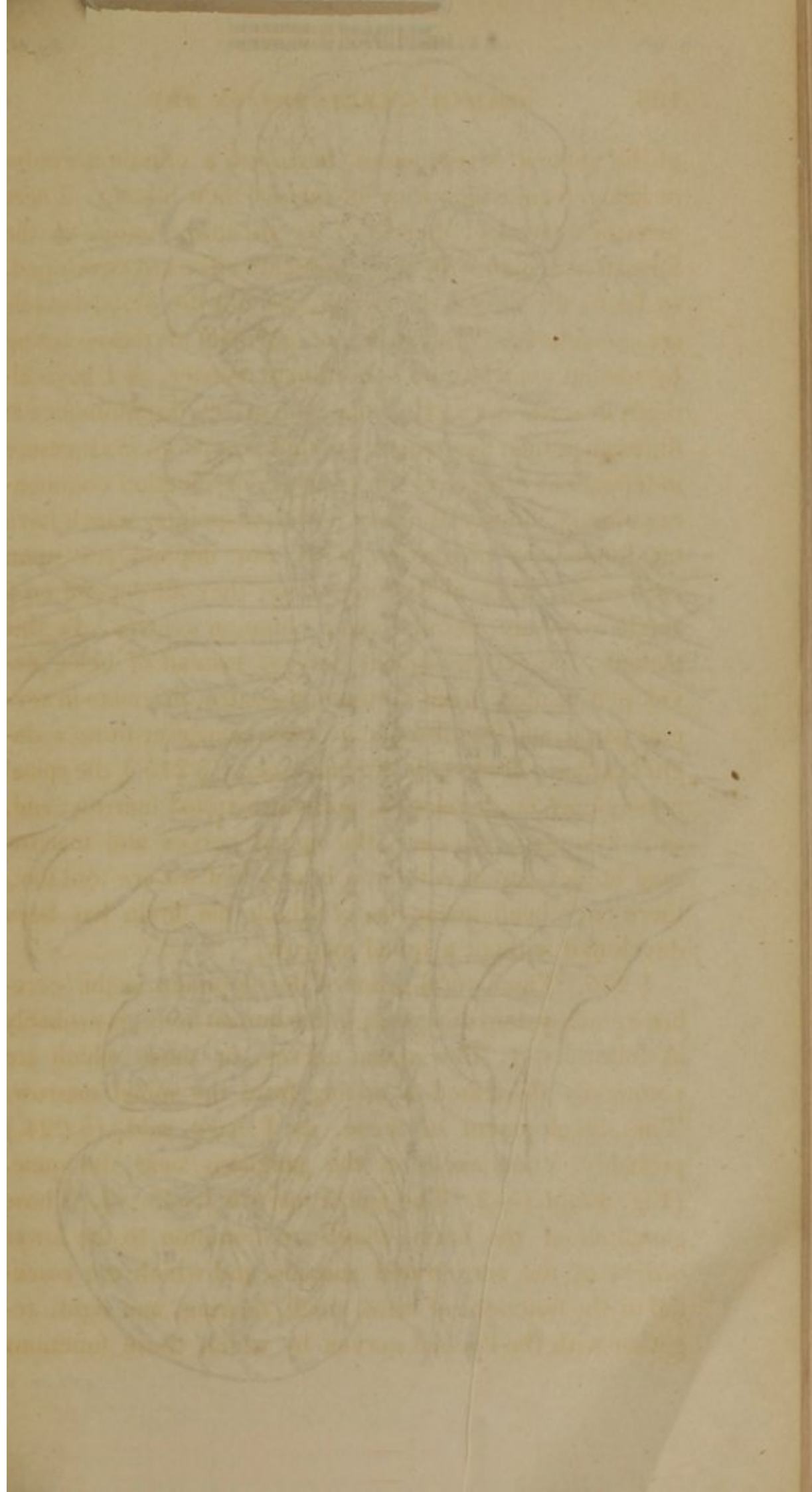
the head, and upper, and lower extremities, are purely and exclusively organs of external relation, and are, to no extent, directly and effectively concerned in the original formation and development of the body; nor in its permanent economy of nutrition and general sustenance; nor are they in any manner, or degree, essential to the life of the body, until respiration and deglutition become necessary. The introduction of proper external substances into the lungs and stomach, and the voluntary evacuations of excrementitious matter, are the only immediate duties which they have to perform, and the only direct agency which they have to exercise, in all the complicated processes of the general function of nutrition.

§ 234. The nerves of organic life then, presiding wholly and exclusively over all the formative processes of organic development, and the cerebro-spinal system being as purely and entirely passive in those processes, as the cartilages and ligaments, it necessarily follows that the organic system is not developed, either from the brain, or spinal marrow, as the original centre of development and point of unity to the formative economy, but the several parts may be, and in fact, are originally formed, in a measure independently of each other, having at first no other connexion than that which is formed by the nerves of organic life, (§ 230.) and by the common system of blood-vessels, by which they are all constructed. As the development of the separate parts progresses, they become more and more nearly associated, and finally, become closely and permanently connected, forming of the whole assemblage, a single system of organs, and establishing by their combined functions, a single vital economy, by which the individual is sustained and the species perpetuated.

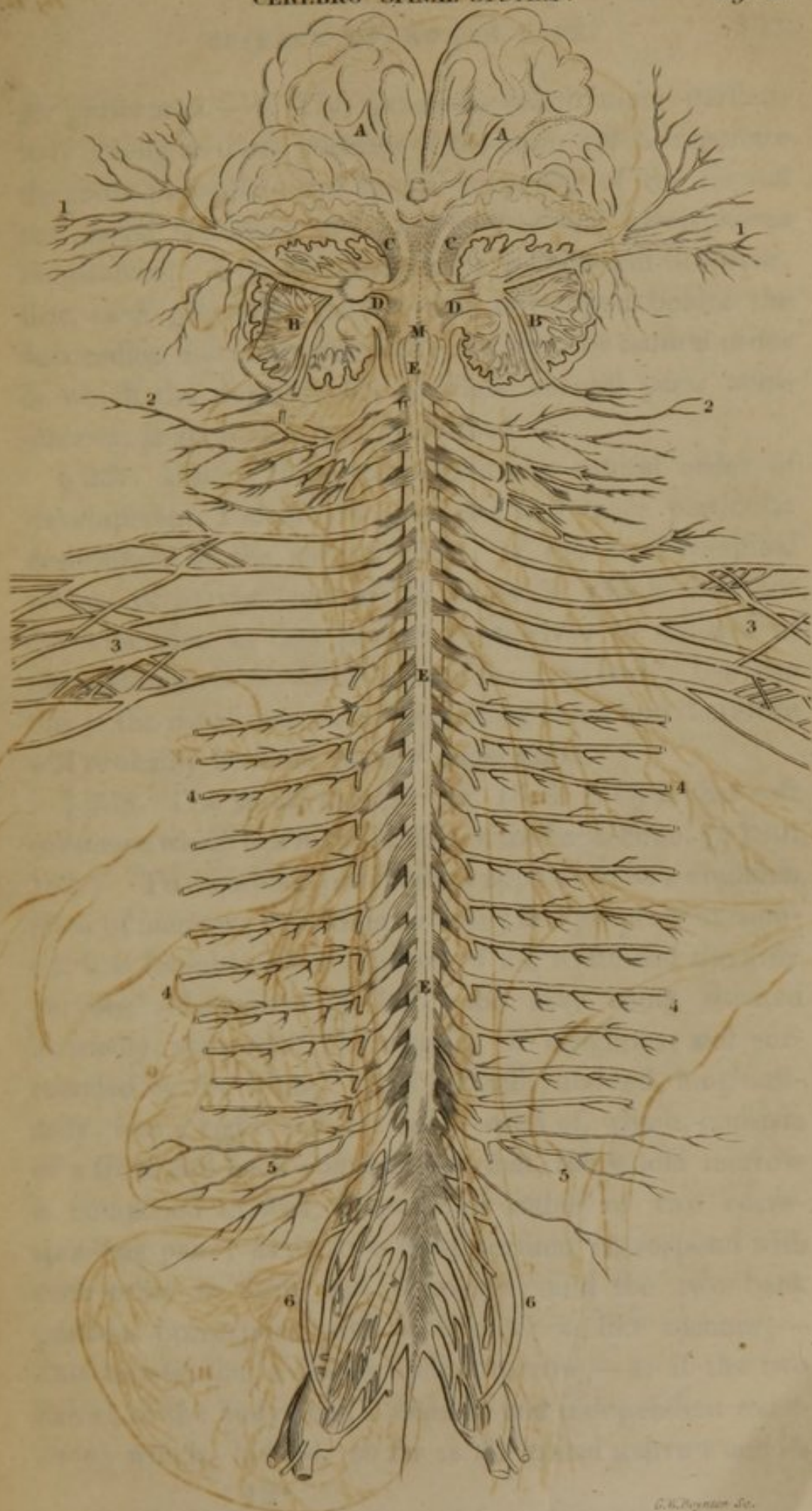
§ 235. The cerebro-spinal nerves therefore, instead of springing from the brain, or spinal marrow, or any other common centre, originate with the parts to which they belong, and in the progress of the general development, become permanently connected with the spinal and cerebral centres. Some modern physiologists indeed, contend that, the nerves of organic life, as well as those of the cerebro-spinal system, originate in the extremities of the parts to which they belong, and terminate in the centre; and that, the formative processes by which organic bodies are developed, are, both in vegetables and animals, effected by a species of vital force, which does not depend on any nervous system; and consequently that the several parts of the body with all their tissues, may be, and probably are originally formed without any connexion with each other, as so many distinct individual beings; and, in the progress of development, become united in a single system. But this is both contrary to fact and to every sound physiological principle and analogy. Whether vegetables have nerves or not, we know that, the economy by which they are developed has a *punctum saliens*, a single starting point; and that, in all its processes, this is the grand point of unity—the general centre of action: and we know with equal certainty, that, this is also true, in the development of animal bodies. A grand centre of unity and of action, is first established, and this is maintained with strictest integrity, throughout the whole progress of development. This centre I have said, (§ 226.) is the central brain of the nerves of organic life, consisting, in the fully developed body, of the semilunar ganglions and solar plexus; and from this common centre, all the subordinate centres with their connecting cords, branches, &c. are developed, by the blood-vessels over which these nerves preside (§ 219.) and which in all stages

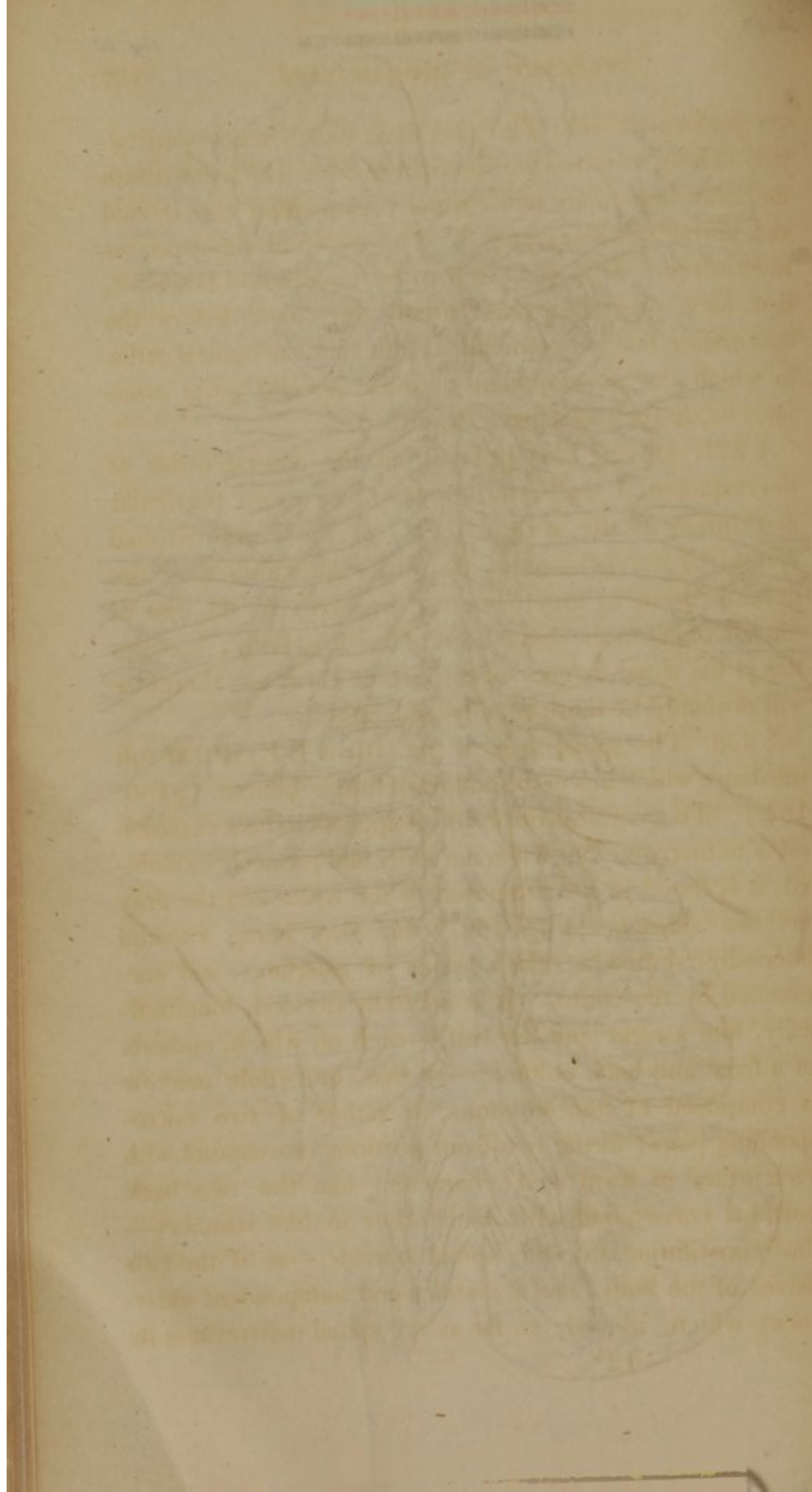
of the general development, have also a common centre or heart, from which they all receive their blood. There must of necessity, therefore, be an entire unity, in the formative economy by which animal bodies are developed, so far as the nerves of organic life and the blood-vessels are considered. But different portions of these, acting by special centres, in a subordinate manner, as I have already described, (§ 219.) may, and in fact, do commence at different points, the structure of different parts, in a measure independent of each other,—just as ossification commences simultaneously at many different points, which have no immediate connexion with, nor dependence upon each other, while at the same time, they all depend on a single economy, acting from a common centre. In this manner, the cerebro-spinal nerves, instead of being developed in unity from a common centre, originate in several parts, and by subsequent connexion, constitute a single system. Hence, as we have seen, (§ 215.) the spinal nerves may be developed, without a spinal marrow, and, as is frequently the case, the spinal nerves and marrow may be developed without a brain; and we are told that, there have been instances in which the brain has been developed without a spinal marrow.

§ 236. The natural order of development in the cerebro-spinal system of nerves, in the human body, is probably as follows:—1. The spinal nerves, or those which are commonly described as arising from the spinal marrow. The development of these, as I have said, (§ 224.) probably, commences at the ganglions near the spine. (Fig. 17. *d.*)—2. The spinal marrow itself. 3. Those ganglions of the brain, which are common to the lower orders of the vertebrated animals, and which are essential to the functions of taste, smell, hearing, and sight, together with the special nerves by which these functions









are performed.—4. The ganglions which more particularly belong to those portions of the brain which constitute the more immediate and special organism of the mental and moral faculties; and 5. The cerebral hemispheres themselves. I do not mean to be understood however, that, each preceding part is fully developed before the succeeding one is commenced; but that the natural order in which the development of these several parts commences, is such as I have described.

§ 237. Having thus pointed out the natural order of development, I shall now, proceed to a more particular description of the several parts, of the cerebro-spinal system of nerves; not in the order in which they are developed but as they present themselves to the eye of the anatomist in the dissections of the dead body; because this is the usual manner of describing them and therefore will probably be more readily understood.

§ 238. The spinal marrow (fig. 16. E E E) is that soft substance which lies in the hollow of the back-bone. (§ 180. 182.) To a careless observer, it appears to be a common mass of marrow: but when carefully and properly examined, it is found to be composed of the white and the gray nervous substances: (§ 161.) the gray being situated internally, somewhat like a series of ganglions, and surrounded by the white. It is naturally divided, longitudinally, into a right and left half:—each of which, consists of a front and back column:—so that, the whole marrow is composed of four columns, or rather of two corresponding pairs; as the two front portions correspond with each other in form and character; and the two back portions correspond with each other in like manner;—thus constituting a double spinal marrow,—as if the two halves of the body, had a distinct and independent existence; which, indeed, so far as the spinal marrow and its

nerves are concerned, is really the case. For, as we shall see, the whole of one side may be paralyzed while the other remains in the full possession of its powers.

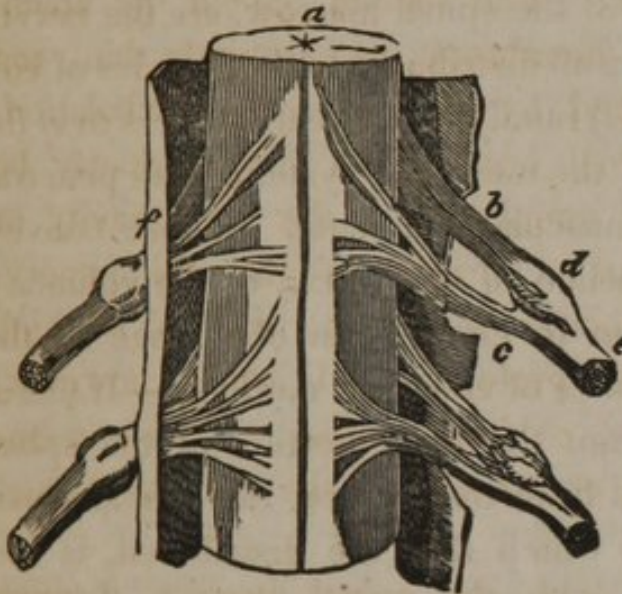
§ 239. The spinal marrow is enveloped in three different membranes.—The first, which everywhere closely adheres to it, is full of blood-vessels that are supposed to nourish it, and hence the membrane is called the *pia-mater*, or natural mother. The second, called the arachnoid or spider's-web membrane, is extremely thin, and is continually moistened by its own serous exhalation. The third, or external one, which may properly be considered the lining membrane of the bony cavity or canal, is a strong fibrous membrane, like that which everywhere surrounds the bones: and some anatomists think this a continuation of the periosteum. It is here, however, called the *dura-mater*, or hard mother. These membranes are all three composed of the cellular tissue. (§ 169.)

§ 240. Connected with the spinal marrow, through small intervertebral openings formed for the purpose, on each side of the spinal canal, are thirty pairs of nerves, which are called the spinal nerves. (Fig 16. Nos. 2. 3. 4. 5. 6.) Each of these nerves consists of numerous filaments, surrounded by the *pia-mater*, and an external envelope of strong cellular membrane, resembling the *dura-mater*, and which, some anatomists consider a continuation of the *dura-mater*; but others are of a different opinion.

§ 241. As the cerebro-spinal nerves on each side of the middle line, or in each half of the body, are precisely alike, it is most convenient to describe them on one side only. I shall therefore adopt this method, and I wish it to be understood that, when I speak of a single nerve it is one of a pair,—the corresponding one being on the opposite side.

§ 242. According to Sir Charles Bell, Magendie and others, a part of the filaments which compose each spinal nerve, rise from [or terminate in] the back portion, and a part from the front portion of the spinal marrow. (Fig. 17.) Those which rise from the back portion, (*b*) almost immediately run into a ganglion, (*d*) and proceeding

Fig. 17.



A section of the spinal marrow, showing the connexion between it and the spinal nerves by double roots.

a, spinal marrow.

b, root of spinal nerve from back portion.

c, root from front portion.

d, ganglion on the posterior part.

e, the two parts united in one cord.

from this, they unite with those that come from the front portion (*c*) and form the cord (*e*) which goes out to be dispersed over the body. But in entering into the formation of the cord, the filaments retain their filamentary form and original character, and are again, ultimately, separated. The filaments which rise from [or terminate in] the back portion of the spinal marrow, are the nerves of animal sensation. Some few of these are distributed to the muscles of voluntary motion, and endow those organs with a small degree of animal sensibility, by which the mind is informed of the action of the muscles in obedience to the will, and enabled to regulate the extent of the action. The rest of the posterior filaments, proceed to the outer skin of the body, and by endowing it with a high degree of animal sensibility, constitute it, a

general organ of touch;—which is the fundamental animal faculty of external relation. They however abound more in some parts than in others;—making particular portions of the body, the more special organs of touch. In man, the ends of the fingers are pre-eminently qualified for this function.

§ 243. The filaments which arise from [or terminate in] the front portion of the spinal marrow, are the nerves of motion. They are all distributed to the muscles of voluntary motion, (§ 194.) ramifying in great numbers over the whole of this part of the muscular system, and penetrating to the smallest muscular filaments. These convey the stimulus or influence of the WILL, to the voluntary muscles, causing them to contract in obedience to the WILL, in the performance of voluntary motions.—If therefore, the filaments from the back portion of the spinal marrow, be separated from that centre, the animal sensibility of the parts to which they are distributed, is immediately destroyed, or in other words, the animal centre of perception has no longer cognizance of any sensations or affections in those parts; yet the power of voluntary motion will remain. But if the filaments from the front portion of the spinal marrow, be separated from that centre, the power of voluntary motion of the parts to which they are distributed, will be lost, while the sensibility will remain.

The Medulla Oblongata.

§ 244. The same column of nervous matter, which, in the hollow of the back-bone, is called the spinal marrow, continues upward, and passing through a large foramen or opening in the base of the skull, extends about an inch into the cranium. (Fig. 7. g.) Near its entrance

into the skull, according to Meckel and others, its two lateral parts divide into several fasciculi or cords, which cross obliquely, so that, those from the right side take the left, and those from the left, take the right: and, at the same time, they are enlarged by the addition of masses of gray substance. (§ 161.) The head of the spinal marrow is now divided into six parts, or three pairs of bodies: (fig. 18. M) two corresponding ones in front, (*h*) called the **PYRAMIDAL BODIES**;—two corresponding ones behind, called the **RESTIFORM BODIES**: and two corresponding ones at the sides, (*i*) called the **OLIVARY BODIES**. These last, are principally composed of the gray substance, surrounded by a thin layer of the white. Besides the parts which I have described, there is, according to Sir Charles Bell, a convex strip of medullary matter, lying between the restiform and olivary bodies, and extending down, between the anterior and posterior portions of the spinal marrow, (§ 238.) which gives origin to the several nerves particularly associated in the function of respiration. (Fig. 15.) These three or four pairs of bodies, are so united as to form a single bulb, about one inch in length and about two thirds of an inch in diameter and commonly called the *Medulla Oblongata*. (Fig. 18. M.)

§ 245. From the sides of this bulb, rise several pairs of nerves, and from its top, all the other parts within the cranium, which I will briefly describe in order, from below upwards.

In the region of the neck, a number of branches and filaments, from several different nerves, unite to form a nerve which descends to the diaphragm and is concerned in the function of respiration. (Fig. 15. No. 12.) In its course from its origin to its termination, it gives off twigs which go to different parts, and unite with twigs from the ganglionic nerves of the neck, with branches

from the solar plexus, and with other important nerves. This nerve belongs to that portion of the respiratory apparatus, which ordinarily acts without the agency of the WILL, but which the WILL can act directly upon, and to a limited extent, control.—The next nerve above, called the spinal accessory, (fig. 15. Nos. 10. 11.) has an extended origin. Some of its roots arise from the lower part of the marrow of the neck, others from the middle, and others from the upper part of the same region. These all enter the skull with the spinal marrow, and after receiving three or four roots from the medulla oblongata, unite to form a cord which passes out at a small opening in the base of the skull, and is distributed to the muscles of the neck concerned in moving the breast and collar bones and shoulder blade, and in drawing back the head and shoulders. This is one of Sir Charles Bell's respiratory nerves; and according to that distinguished anatomist, both this and the diaphragmatic nerve spring from the middle strip of medullary matter, which I have named.—Of those nerves which have their origin entirely within the skull, the lowest is called the hypoglossal. It arises by a series of roots, from the groove between the pyramidal and olivary bodies, and passes out at another small aperture in the base of the skull, and after giving off twigs in several directions, and receiving twigs from other nerves, it divides into many branches which are distributed to the muscles of the tongue, imparting to them the power of voluntary motion in mastication, swallowing, speaking, singing, &c. (Fig. 15. No. 9.) The nerve next in order above, is called the pneumo-gastric, or the lungs-and-stomach nerve. (Fig. 15. Nos. 1—6.) It arises by numerous roots, very near the top of the medulla oblongata, and according to Sir Charles Bell, from the respiratory strip between the restiform and olivary bodies. It issues from the

skull with the spinal accessory: and by numerous branches and twigs, forms connexions and plexuses with almost every nerve in the region of the throat and neck, and thoracic cavity, to such an extent, that it has been called the middle sympathetic. It sends branches to the pharynx or top of the meatpipe and to the meatpipe itself, (2.) to the larynx or organ of voice at the top of the windpipe, and to the windpipe, in all its branches, and whole extent.—It also sends branches which unite with others from the cervical ganglions of the sympathetic, to form what is called the cardiac plexus, (5.) and at the bottom of the neck, it sends back a recurrent branch to the larynx and windpipe and other adjacent parts: (3.) and these different branches interweave and unite in every direction so as to bring the organs of the throat and neck into very direct and important relations. Several branches of this nerve also enter into the formation of plexuses for the lungs: (4.) and some twigs extend to the solar plexus, to the plexus of the liver, spleen, &c.: but the main body of this nerve descends to the stomach (6.) and is distributed over that organ, interweaving and uniting extensively with the nerves which come from the solar plexus—the great centre of organic life.

§ 246. This nerve has been the subject of more speculation and experiment and discussion and controversy among physiologists, than perhaps any other portion of the human system. Some, as I have stated, have considered it the middle sympathetic nerve, the office of which, is to maintain a direct sympathy between all the parts to which it belongs, and especially between the brain and stomach.—Some have supposed that it is simply the medium by which the want of air in the lungs and of food in the stomach, is communicated to the animal centre of perception and action.—Others, that it conveys

to the lungs and stomach, the nervous energy by which those organs are enabled to digest the inspired air and the ingested food.—Some have considered it an animal nerve; and others a vegetative nerve.—Some have thought it wholly a nerve of sensation and others, that it is both a nerve of sensation and motion,—and others again, contend that it is exclusively a nerve of motion.—It has been tied and cut and experimented on in various ways, and with various results, in the minds of the experimenters, according to their particular theories. Some assert that if it be cut or tied, digestion, respiration and the action of the heart are entirely arrested, while others contend that digestion is only temporarily interrupted, and respiration is arrested only by the closing of the top of the windpipe; and that the action of the heart may be restored by artificial respiration. But in all these experiments, the sympathies of the system seem to have been wholly overlooked. (§ 206. 216.) Sir Charles Bell tells us that it is exclusively a respiratory nerve, and that it immediately or remotely, associates all the parts to which it is distributed, in the function of respiration.

§ 247. Amidst such a wilderness of discrepant opinions and statements, it is impossible to decide from their authority, where the truth lies; but there are several important considerations which should ever be kept in view, when we attempt to arrive at a conclusion on this vexed question. In the first place, this is a large nerve issuing from very near the top of the medulla oblongata;—a point towards which, all other parts in the body below and in the skull above, seem to converge.—In the second place, it not only anastomoses, or forms connexions, by numerous branches, with several other nerves issuing from the cranium, but also anastomoses freely, and even forms plexuses with the nerves of organic life,

from the cervicle and thoracic ganglions of the sympathetic. In the third place, the main body of this nerve, proceeds very directly to, and expends itself upon the stomach, as if that organ were its grand point of destination, and all its other distributions, secondary or of less importance. (Fig. 15. No. 6.) It is said to send some branches to the heart, but all those branches are first merged in plexuses with nerves of organic life, and few, if any of them, reach the heart, even in a modified form. Those branches which go to the substance of the lungs, are also, much involved in anastomoses, and plexuses, and perhaps, considerably modified by other nerves, before they reach their destination. In the fourth place, some filaments of this nerve extend to the great centre of organic life, or solar plexus, (§ 226.) and the plexuses immediately formed from it and surrounding it. Would this be the case, if it were simply a motor nerve? In the fifth place, it is pretty certain that, those branches of this nerve, which are distributed to the pharynx and larynx, and the muscular portion of the windpipe, are nerves of voluntary motion: and that, the section, or paralysis of them destroys the vocal power and the power of deglutition, or swallowing:—and it is entirely certain that, the WILL has no direct control over that large portion of this nerve which is distributed to the stomach: nor is there the least reason to suppose it has, over those branches which reach the substance of the lungs. Moreover, it is very certain that in the stomach, the pneumogastric is not a nerve of common animal sensibility or feeling: while its branches in the lining membrane of the larynx and windpipe, appear to be highly sensible. Finally; the special sense of hunger and of thirst and the well-known, direct and powerful sympathy that exists between the brain and the stomach, seem to require the agency which

has long been attributed to this nerve. Indeed, it appears to occupy a middle ground between the nerves of organic and animal life; and, if such a thing can be, I am inclined to think that, in its origin, it is an animal nerve of sensation and motion and after forming its great plexus, and becoming intimately associated with the nerves of organic life, it becomes an animo-organic nerve of the same powers, giving motion, perhaps, to the bronchiæ and certain motions to the stomach, which take place in vomiting, &c. and constituting the medium by which the centre of animal perception has cognizance of those wants of the organic domain, which are indicated by hunger, thirst and the desire for air; and by which also, the brain and stomach and other parts associated by this nerve, are brought into more direct and powerful sympathy with each other. Something very analogous to this is found in the trifacial nerve, if it be true that that nerve endows the tongue with gustatory power. But, whatever the pneumogastric nerve may have to do with the motions, sensibilities and sympathies of the stomach and lungs, the general law of physiological analogy teaches us that, it is not directly and immediately concerned in the important changes which take place in them,—these depending entirely on the vital properties and functional powers of the nerves of organic life, connected with the capillary vessels of those organs. (§ 230.)

§ 248. The next nerve in order, is called the glosso-pharangeal—or tongue-and-pharynx nerve. (Fig. 15. No. 8.) It rises by numerous filaments from the groove between the restiform and olivary bodies, immediately above or before the pneumogastric, and passes out of the cranium with the latter nerve. Indeed, some anatomists think it actually forms a part of the pneumogastric. Sir Charles Bell classes it among his respiratory nerves.

—On its exit from the skull, it gives off several branches which unite with other nerves and supply many parts in the region of the throat: but it is mainly distributed to the pharynx and tongue. According to Sir Charles, it gives motion to the muscles of the tongue and pharynx: and more especially those, necessary for the articulation of the voice.—Spurzheim on the contrary, says “this nerve appears to be destined to general sensation or feeling. Another nerve rises immediately above and on the same line with the one just described, which is called the facial nerve. It passes out at an opening near the ear, and is principally distributed to the muscles of the face;—being dispersed over the chin, lips, angles of the mouth, cheeks, nostrils, eyelids, eyebrows, forehead, ears, neck, &c. and uniting in its ramifications, with the branches and twigs of several other nerves.—(Fig. 15. No. 7.) This is another of Sir Charles Bell’s respiratory nerves: and according to him, it is the principal muscular or motor nerve of the face, and orders all those actions which are, in any degree, connected with the acts of respiration: and on it the expressions of the face depend.—The next nerve is called the abductor, or external muscular nerve of the eye. It rises from the top of the pyramidal body, and passes out at an opening in the back part of the cavity formed for the eyeball, and goes to the muscles which turn the eye outward. This nerve is entirely appropriated to voluntary motion. (Fig. 18. No. 6.) There are six other pairs of nerves—including those of special sense, which originate within the cranium, and all of which, actually rise, either directly or indirectly, from the top of the medulla oblongata: but their roots are so covered by other parts—or, they originate in a manner so diffuse and

indistinct, that they have the appearance of springing from parts removed from that point.

§ 249. In describing the remaining nerves, I shall deviate from the usual order, and proceed in a method of my own, for the sake of placing important points in the strongest light, with reference to physiological relations. The nerve which next presents itself as we proceed forwards, is the auditory, (fig. 18. No. 8.) and the next is the trifacial:—(fig. 18. No. 5.) both of which, I shall leave for the present, and pass to the two remaining muscular nerves of the eye.—The internal motor nerve of the eye, is the smallest that originates within the cranium. (Fig. 18. No. 4.) It is the highest of Sir Charles Bell's respiratory nerves, and according to that gentleman, it rises from the very top of the medullary strip which gives origin to all of the nerves of the respiratory apparatus (§ 244.) and which terminates upwards and forwards, just under the masses called the corpora quadrigemini. This nerve passes out of the skull, with the nerve last described, and goes to the superior oblique muscle of the eye, which rolls the eye and turns the pupil downward and outward, and gives the pathetic expression to the eye, and hence this nerve is called the pathetic. The common motor nerve of the eye (fig. 18. No. 3.) rises by numerous filaments, which may be traced back nearly to the top of the medulla oblongata, and are then lost in parts coming from that point. The filaments soon unite and form the nerve, which passes out at the same opening with the last two described nerves, and is distributed to the greater number of the muscles of the eye, which serve to direct the pupil towards the objects of vision.

§ 250. The nerves which remain to be described, are those of special sense, and the trifacial. All these

have their origin at, or near the focal point, at the head of the medulla oblongata, from which all the parts within the cranium rise and diverge. This, it must be remembered however, is according to the usual mode of anatomical description, rather than according to the natural order of development. It is highly probable if not certain, as I have said, (§ 236.) that the parts within the skull, do not actually spring from the medulla oblongata, but that, the cerebral ganglions, such as the quadrigeminal, the ophthalmic and the striated bodies are first formed, or commenced, in regular order of succession, and in due time, united with the medulla oblongata and with each other, by medullary fibres, and that from these are developed the parts more particularly connected with them. The quadrigeminal bodies are four small ganglions lying at the top of the medulla oblongata. A little removed from these, are the two largest ganglions of the brain, called by the old anatomists the optic thalami, being supposed to give rise to the optic nerves: and still a little removed from these last, are two smaller ganglions called the striated bodies. All of these bodies are principally composed of the gray substance, (§ 161.) surrounded and traversed by the white or medullary fibres; and all lie near the centre and base of the brain, and occupy but a small portion of the cranial cavity.

§ 251. Anatomists have attempted to demonstrate the precise points at which the olfactory, optic and auditory nerves rise from these bodies:—but no one has yet been so successful as to place the matter entirely beyond dispute. As these nerves are traced backward and inward towards their origin, they become less and less distinct, and more and more indefinite, till they fade into the substance of the parts from which they rise, and evade pursuit: and this is particularly the case with the optic and

olfactory nerves. Indeed, all these nerves appear to have a general relation to all the parts rising from, or terminating in, the common centre of animal perception and voluntary action, at the top of the medulla oblongata.

§ 252. The auditory nerves, (fig. 18. No. 8.) are endowed with the power of receiving those impressions which we call sounds, and are distributed to the inner cavities of the ear as the special nerves of hearing. The olfactory nerves are endowed with the power of receiving those impressions which we call smell. They proceed forwards, and before they make their exit from the skull, they are considerably enlarged by a quantity of the gray substance. (Fig. 18. No. 1.) They then pass out through a number of small apertures, and are distributed over the cavities of the nose, forming the external organ of smell. The optic nerves proceed forwards a short distance from their origin, and then come together and form a junction, and again immediately separate, and continue forwards, and make their exit from the skull through the optic foramen, and having passed through the outer coats of the eyeballs, they finally terminate in a delicate expansion, called the retina, which surrounds the humors of the eye. (Fig. 18. No. 2.) The nature of the union which these nerves form at their junction, is yet a matter of uncertainty. Anatomists and physiologists not only disagree on the subject, but in their arguments and in their statements of facts, directly contradict each other. Some assert that the two nerves cross each other entirely, so that, the nerve which rises on the right side, goes to the left eye, and that which rises on the left side goes to the right eye. These support their opinion by an array of pathological and other facts and reasonings, which are very convincing and conclusive. But others assert that there is only a junction and no crossing of the nerves, and that

even the junction is not essential to their functional powers. These again, by facts and reasonings, make out their case, as clearly and as conclusively as those of the former opinion;—while yet others contend that there is a partial decussation, and establish their position most conclusively by facts and reasonings;—and still others, with equal force of facts and arguments, prove that there is no decussation, but an intimate and essential union of the substance of the nerves. From such contradictory statements, it is impossible to know what is true: but we have the satisfaction of knowing that whatever be true in the case, it is of little importance to physiology. The optic nerve is endowed with the power of receiving those impressions which we call sight. It is the special nerve of vision, and is always present where the faculty of vision exists.

§ 253. The peculiar endowments of the nerves of special sense, are generally considered as modifications of common animal sensibility; but there is some reason to doubt the correctness of this opinion. It is certain that these nerves, at least in a healthy state, have no tactile sensibility. The optic nerve is no more sensible to a puncture or laceration, than a dead tree, but it is most delicately sensible to light, which we can in no other possible manner appreciate nor perceive. Nor is there the least foundation for the notion which some have advanced, that other nerves may in some degree, vicariously perform the functions of these nerves, in their absence. Indeed, the sense of touch is in all respects, as truly a special sense as that of sight, hearing, smell or taste. It is much more extensive in its special organism, than any other sense, only because the relations of the animal to the tangible properties of things, require that it should be so; but the extensiveness of its organism does

not in any measure, render the sense less specific. If the optic nerve, instead of being expanded into the retina of the eyeball, were expanded like the skin, over the whole external surface of the body, so that the animal could see, as he can feel, at every point, the optic sense would be no less a special sense than it now is: because the speciality of a sense does not consist in the limitedness of its peculiar organism, but in the *specificness* of its power. The sense, of sight is a special sense, not because we can only see with the eye, but because we can only perceive special properties of external things by it, which we call the visual properties of things: and so of all the other senses called special. But the sense of touch is as specific in its power as either of the other senses; for by it, we can only perceive the tangible properties of things, and therefore, it is the special sense of touch notwithstanding the faculty pervades the whole body.

§ 254. I now return to the trifacial nerve, or the fifth of the old anatomists. This is the largest nerve within the cranium, and in many respects, corresponds with the spinal nerves. Like them it rises by two roots,—has a ganglion, and is both a nerve of sensation and motion. (Fig. 18. No. 5.) In birds and other animals which have no annular protuberance, this nerve is plainly seen, rising from the pyramidal and restiform bodies of the medulla oblongata; but in man and other animals which have a large annular protuberance, the origin of the nerve is not so easily perceived. The posterior root of this nerve, coming from the restiform body, is much the larger, and is composed of thirty or forty fasciculi of different sizes, containing in all, about a hundred filaments, which interlace freely as they proceed forward to form the semicircular prominence or enlargement called the gasserian ganglion. This portion of the nerve is endowed with

animal sensibility. The anterior portion which arises from the pyramidal body does not enter the ganglion. This is the motor portion of the nerve, and is ultimately distributed to those muscles of the face, concerned in mastication, &c. From the gasserian ganglion the nerve proceeds in three large branches; called the ophthalmic—the superior maxillary and the inferior maxillary. (Fig. 16. No. 1. 1. 1.) The ophthalmic is principally distributed to the eye, giving sensibility to the surface of the ball and the parts that surround it, sending some twigs to the nose, &c. The superior maxillary is distributed to the upper part of the face, upper jaw, roof of the mouth, superior salivary glands, gum, lip, &c.,—sending a twig to each root of each tooth, (fig. 23.) and ramifying generally, over all the parts connected with the upper jaw; some twigs extending to the cavities of the nose and interlacing with twigs of the olfactory. The inferior maxillary is distributed to the lower parts of the face, mouth, and region of the ear; supplying the teeth, jaw, gum, inferior salivary glands, tongue, lips, chin, &c., and some of its twigs extend to the internal auditory apparatus of the ear. The inferior maxillary, also gives rise to the branch which, after peculiar modifications, is endowed with the power of receiving those impressions which we call taste, and is distributed by minute filaments to the mucous membrane of the mouth and throat, and particularly upon the edges and tip of the tongue, and thus forming the special organ of taste.* In short, the trifacial nerve is distributed to

* There is some question whether the inferior maxillary branch of the trifacial, does actually furnish the gustatory nerve. Many experiments have been made on living animals, to settle this point: but the parts are so complicated, and different nerves are so closely associated, that nothing perfectly satisfactory and conclusive, has yet been ascertained.

every part of the face, forehead, eyelids, nose, lips, jaws and ears; and in its extensive ramifications, it anastomoses or unites freely with the facial nerve, with several other nerves of the head, and with a great number of twigs from the sympathetic, of organic life. It communicates with the organs of all the five senses, and of voluntary motion, and brings these and all other parts to which it is distributed, into general relationship: and it also brings all these parts into a more direct and powerful relation with the stomach and the whole domain of organic life. This is the universal nerve of sensation to the head and face, to the skin, to the surface of the eye, to the cavities of the nose, mouth, tongue, &c.

§ 255. The trifacial nerve has been the subject of much physiological research, experiment and speculation. It has by some, been called the sympathetic of the head; and there certainly are many interesting analogies between this nerve, the pneumogastric and the sympathetic of organic life. (§ 227.) Tiedemann however, conceives that this last nerve is sufficient to answer all the sympathetic purposes of the body: and as a medium of general sympathy it undoubtedly is. Yet both the trifacial and the pneumogastric may act in their spheres, as special sympathetics, bringing into more special and immediate relationship particular parts, which are collectively embraced by the great sympathetic, without at all interfering with the functions of this last nerve. In a state of extended inflammation, or a high degree of morbid sensibility, the trifacial nerve is certainly the medium of morbid sympathy between different parts to which it is distributed. The protracted irritation of the nerve of a decayed tooth, often gives rise to ear-ache, head-ache, &c.—and sometimes, these sympathetic symptoms continue constantly for years, or until the tooth is extracted. And we know

too, that those parts to which the trifacial is distributed as the principal nerve, sympathize very powerfully with the stomach, especially in a diseased state; as the eyes, ears, teeth, &c. In that distressing complaint, called sick head-ache, it is probable that both the trifacial and the pneumogastric nerves are much concerned.

§ 256. Such is the importance of this nerve to those of special sense, that some physiologists have supposed it immediately essential to their functional powers; and some have even asserted, that the functions of sight and smell, are performed in certain animals, by the branches of this nerve, in the absence of the optic and olfactory. But most unquestionably, these opinions are erroneous. Yet it is entirely certain, that the division of those branches which go to the eye and nose, will instantly destroy the sensibility of the parts, and soon cause a total abolition of sight and smell; and all injury done to these branches, commensurately impairs the functional powers of the optic and olfactory nerves:—so intimately connected and reciprocally dependent are the several parts which compose a single organ and a whole system.

§ 257. There is one other view, presented by some physiologists, of the trifacial nerve, which is exceedingly interesting and plausible.—It is that this nerve is peculiarly the cerebral organ of animal instinct. It is said that in the vertebrated animals, the development of instinct appears to be in a direct ratio with the trifacial; and that in those articulated animals whose brain corresponds with the gasserian ganglion of the trifacial nerve, the instinctive powers are more developed than in the members of other classes.

§ 258. The originators and advocates of this opinion affirm that the brain and trifacial nerve are always developed in an inverse ratio; and that the development of the

trifacial, and the instinctive faculties always bear a precise relation to each other. "Man," say they, "is governed by reason and not by instinct, and in him, the trifacial nerve, in comparison with the other parts of the nervous system, is reduced to its minimum of existence. The monkey, the dog, the elephant, and most of the higher mammalia, though immeasurably below man, appear to be directed by a kind of brute reason. In these animals also, the trifacial bears but an inconsiderable proportion to the general nervous mass;—the instinctive faculties are indeed manifest, but not carried to the extent they are met with, in many of the lower orders. In the seal and beaver, among the mammalia, these faculties are at their highest pitch of development, and seem rather to be the effect of an unerring reasoning power than the result of the organization of instinct. In these animals the brain is reduced to a state of atrophy, whilst the trifacial is carried to an enormous extent of development. In the wasp, the bee and the spider, and especially in the bee, instinct is carried to its highest perfection. And here the brain is wholly wanting; the gasserian ganglion being the predominating part of the nervous system in all the invertebrata, and in the bee this organ is carried to its highest point of complexity and organization."

§ 259. All the parts of the nervous system which I have described, may be developed, and all the functions immediately essential to animal and organic life, may be performed, without the brain. "Many instances are on record of human beings, which were entirely destitute of the proper brain, and in which the two gasserian ganglions approached each other and became confounded in one general mass, and with this, the olfactory, optic, auditory and other nerves of the head, were connected, and during the life of the individuals the functions of smell, vision,

hearing and taste were perfect." But these are monstrosities of nature; and fortunately are of rare occurrence. They however, serve to demonstrate the relations and dependencies of parts; and sometimes teach us important physiological truths, which it would be difficult, if possible for us to ascertain in any other way.

§ 260. We see therefore, that the spinal marrow and the spinal nerves, together with the medulla oblongata and the several pairs of nerves within the cranium, are all purely and exclusively the agents of animal sensation, perception and voluntary motion: and that the brain itself, instead of being a galvanic apparatus employed in generating the nervous power or vital stimulus of the whole system, is appropriated entirely to the intellectual and moral powers and manifestations, and has little more to do with the rest of the body than to depend on its general organic economy for its own sustenance, and to constitute the special organism through which the mind is acted on by the body, and in turn, acts on the body—directly, in the exercises of the WILL, and indirectly in all mental excitements and emotions.

LECTURE VI.

The brain—the order of its development and the relations of its parts—Gall's views—Spurzheim's views—Tiedemann's views—Number of cerebral organs described by Gall—Number added by Spurzheim—Common centre of the cerebro-spinal system—Duplicate and symmetrical form of this system—Not so in the nerves of organic life—Connexions between the nerves of organic life and the cerebro-spinal system—Skin and mucous membrane, their structure and general functions as media of nervous connexion and sympathy—Organic and animal sensibility, described—Centre of animal life no perception of, nor control over the functions of organic life—Nerves of organic life no animal sensibility—External senses and their relations—touch, taste, smell, hearing, sight—Special senses of organic life—Sympathetic relations between the different parts in organic and animal life—The powerful sympathetic relations between the stomach, brain and all other parts—Sympathies, sources of happiness and of misery—Organic sympathies excited by poison—Morbid sensibility in nerves of organic life—Sympathetic relations between the nerves of organic life and the mind—Influence of the mind on the body—Of the body on the mind—Hereditary predispositions, &c.—Nerves larger and more pulpy in early life—smaller and drier in old age.

§ 261. THE parts within the cranium remaining to be described, are the cerebrum or brain and the cerebellum or little brain. The latter occupies the lower portion of the back part of the skull; and the former occupies the whole of the upper and front portion. In common language however, all the parts within the cranium are collectively called the brain, and in the technical language of anatomy and physiology, the encephalon, from two Greek words meaning “in the head.”

§ 262. At first, the contents of the cranium and spinal canal, are, as I have said, (§ 214.) exceedingly soft,—somewhat like the white of an egg. They gradually become more and more consistent, and assume the form of determinate structure and arrangement. It is not, however, until about the seventh year of life that the brain is supposed to have attained to that completeness of development and degree of consistency, which fit it for vigorous functional exercise: and even at this age, the employment of it in severe and continued mental operations, is neither safe nor wise.

§ 263. I have already so fully described the natural order of the original development of the cerebro-spinal system (§ 250.) that I trust I shall not be misunderstood if I now proceed to describe the brain as it presents itself to the eye of the anatomist, in the dissection of the completely developed body, and speak of parts as rising from others, which probably originated separately and in the progress of development, became united.

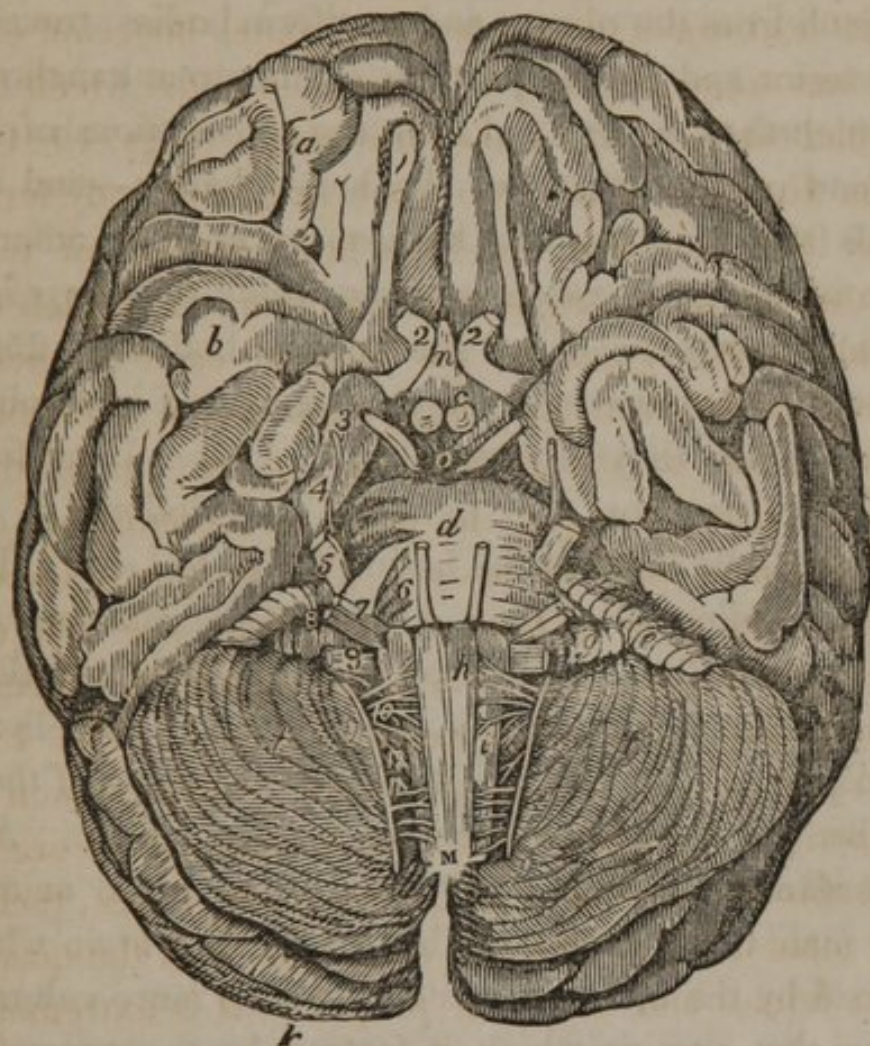
§ 264. The medulla oblongata, or that portion of the spinal marrow which is within the skull, I have said, (§ 244.) consists of three pairs of bodies united in a single bulb, (fig. 18. M) viz. the two pyramidal bodies (*h*) which are continuations up of the two front portions of the spinal marrow, (§ 238.) the two restiform bodies which are continuations up of the two back portions of the spinal marrow, and the two olivary bodies (fig. 18. *i*) lying between the other two pairs, and partly at the sides, which are composed of gray matter thinly surrounded by white fibres, and by some anatomists are considered enforcing ganglions. The bulb thus composed, leans forward in the cranium and rests its anterior surface in a fossa or groove formed for it in the basilar bone. This brings the front portion, or the two pyra-

midal bodies partially under the others, so that the restiform bodies, or the continuations of the back portions of the spinal marrow, are placed somewhat above. Medullary fibres (§ 250.) continuing from these last named bodies, pass through masses of the gray substance by which they are greatly augmented in number, and are reflected backwards in nearly a horizontal line, and expanded into something like a fibrous membrane which by its peculiar foldings, forms the little brain. (Figs. 15. 16. B.) The diverging fibres from each restiform body form a distinct lobe; so that the little brain consists of two lobes—the one on the right and the other on the left of the middle line. Some of the fibres of each of these lobes proceed forwards and taking a transverse direction, meet and unite on the middle line at the top of the medulla oblongata, forming the principal commissure or uniting portion of the little brain. This portion is sometimes called the pons or bridge, going from one lobe to the other; sometimes it is called the annular protuberance; and sometimes, the transverse fibres. (Fig. 18. *d*.) Several pairs of nerves within the cranium which I have described, have the superficial appearance of originating in this body—Besides the transverse fibres, there are also others, which connect each lobe with the quadrigeminal bodies and the brain proper.—It is extremely difficult to describe the parts of which I am speaking, in such a manner as to present a correct image clearly and distinctly to the mind of those who have never seen a naked brain. Fig. 18. *f*, however, is a very good illustration of the general external appearance of the little brain in its connexion with the cerebrum or brain proper. Yet to obtain a clear and accurate idea of it, the brain itself must be seen and examined.

§ 265. The medullary fibres continuing from the

pyramidal bodies of the medulla oblongata, (fig. 18. *h*) together with those from the olivary, (*i*) and perhaps a few from the restiform bodies, proceed forwards and upwards, passing through masses of the gray substance,

Fig. 18.



The base of the brain, exhibiting—*a*, the anterior lobes; *b*, the middle lobes; *k*, the posterior lobes projecting over *f*, the little brain; *M*, the medulla oblongata; *h*, the pyramidal bodies; *i*, the olivary bodies; *d*, the pons varolii; and 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, the different cerebral nerves described in the text.

which are covered by the transverse fibres (*d*) of the little brain;—the olivary fasciculi either traversing or becoming closely connected with the quadrigeminal bodies. Having arrived at the anterior edge of the

annular protuberance, (*d*) considerably increased in number, they form what are called the *crura cerebri* or legs of the brain. (Fig. 16. C C.) They now plunge into the great ganglions of the brain, called, by the old anatomists the optic thalami, (§ 250.) where they are again very greatly increased in number. According to Spurzheim, the fibres or fasciculi from the olivary and restiform bodies, traverse the posterior and middle portions of the great ganglions, from which they diverge and form the convolutions of the upper and posterior parts of the hemispheres:—and the fasciculi from the pyramidal bodies, traverse the anterior portion of the great ganglions from which they pass into the smaller ganglions called the striated bodies (§ 250.) where again, they are exceedingly augmented in number, and from which they diverge (figs. 15, 16. A) and form the inferior, anterior, and external convolutions of the front and middle lobes of the brain. (Fig. 18. *a b*.) The pyramidal bodies (*h*) of the medullary oblongata, he considers the rudiments of such parts of the brain as belong to the intellectual operations, and, in man, the olivary (*i*) and part of the restiform bodies, as the roots of those parts that pertain to the affective manifestations. And in accordance with this view, he says that in the animals below man that portion of the legs of the brain which is formed by the olivary fasciculi, is much more voluminous than that portion which is formed by the pyramidal fasciculi; and as we descend in the scale of being, its relative proportion increases continually; while in man that portion which is formed by the pyramidal fasciculi constitutes two thirds of each cerebral leg. (Fig. 16. C C.)

§ 266. In regard to the arrangement of the medullary fibres in the formation of the convolutions and commissures of the brain, there is a wide difference of opinion

between the most eminent anatomists. "The convolutions internally consist," says Spurzheim, "of white fibres which are covered on their extremities with cineritious substance. These fibres which terminate the nervous bundles of the cerebral crura, are not all of the same length. Many, especially of those which are situated on the outer sides of the convolutions terminate immediately beyond the exterior walls of the cavities;—the others extend to distances progressively greater as they run more centrally,—those of the interior extending the farthest of all. It is in consequence of this peculiar structure that prolongations and depressions are formed on the surface of the hemispheres. The cineritious or gray substance follows all the forms composed by the white fibres and covers every elevation and depression with a layer."

§ 267. Concerning the commissures of the brain or those parts which unite the two hemispheres, he says "they are formed by the *converging fibres*. "Nothing," he continues "can be easier than by dissection to prove the two orders of cerebral fibres—the diverging and converging, and to show that the mass or bundle called the corpus callosum belongs to the converging order." Yet Tiedemann whose authority on this subject, is perhaps equal, if not superior to that of any other man, declares that, these converging fibres have only an imaginary existence, that they are not to be found in the brain and that the corpus callosum is formed before the convolutions (which according to Spurzheim give rise to the converging fibres) begin to appear.

§ 268. I confess that my own inquiries and investigations which have been somewhat diligent and protracted, have resulted in impressions much more in accordance with the views of Tiedemann than with those of Gall and

Spurzheim, in regard to the converging fibres, and the formation of the commissures and convolutions of the brain. If nothing can be easier than by dissection to prove the two orders of cerebral fibres, it is very remarkable that so few have ever succeeded in satisfying themselves by actual dissection, of the existence of the converging fibres. I have conversed with many able anatomists who had dissected many brains, and who believed and taught the doctrine of Gall and Spurzheim concerning these fibres; but I never yet saw the man who by actual dissection had demonstrated their existence.

§ 269. According to Tiedemann, the medullary fibres that issue from the cerebral ganglions which I have already described, (§ 265.) at first form a thin fibrous membrane on each side of the head. These membranes in the progress of development, curve their superior edges in towards the middle line, and these edges gradually meet and unite, and thus form the corpus callosum or great cerebral commissure, and by so doing, at the same time, form the two hemispheres of the brain: which as yet are in a membranous state like two bladders, without any appearance of convolutions: but the membrane is considerably thickened by the additions of new medullary matter on the exterior surface. In this state of the brain the fibres are to be traced from the medulla oblongata to the corpus callosum, and it is evident that the fibres which terminate in, and form this commissure, are the same that come from the legs of the brain: and were the skull sufficiently capacious for an entire development of the cerebral hemispheres in this form, the human brain might come to full maturity of organization and of functional power, without a single convolution. In cases of hydrocephalus, where the hemispheres are completely expanded, they are merely brought back into that

membranous state, in which they were at first. And this, we know, takes place without any perceptible disturbance of the cerebral functions.

§ 270. "Were the diverging fibres of the great cerebral ganglions prolonged directly into the corpus callosum," says Spurzheim, "it would be extremely difficult to understand how they could be elongated to the degree occasionally observed in hydrocephalus." But the difficulty here contemplated, is purely imaginary. It is not claimed that in the normal state of a fully developed brain, the fibres proceed *directly* from the ganglions to the commissure; but that the membrane formed by these fibres is so folded in and out, upon itself, as to form what are called the convolutions of the brain, and so as to bring the greatest extent of surface within the capacity of the skull. It is therefore very easy to understand how water slowly accumulating in the cavities of the brain, gradually raises up the corpus callosum and enlarges the capacity of the skull and unfolds the hemispheres into their expanded membranous form, without lacerating any of the cerebral texture or disturbing any cerebral function. It is before the convolutions are formed, and in those cases of hydrocephalus in which all the convolutions are unfolded, and the hemispheres completely expanded into their original membranous state, that the fibres proceed directly or rather in a curved line from the ganglions to the corpus callosum. I have not found it very difficult to unfold the hemispheres of a recent brain in this manner, and spread it out into an extended membrane with no other laceration of the parts than was necessary at the edges, in order to bring a natural hemisphere into a plane: and when thus unfolded it is very easy to see the blood-vessels ramifying over the whole internal surface, and to perceive the medullary fibres radiating like the sticks of an open fan,

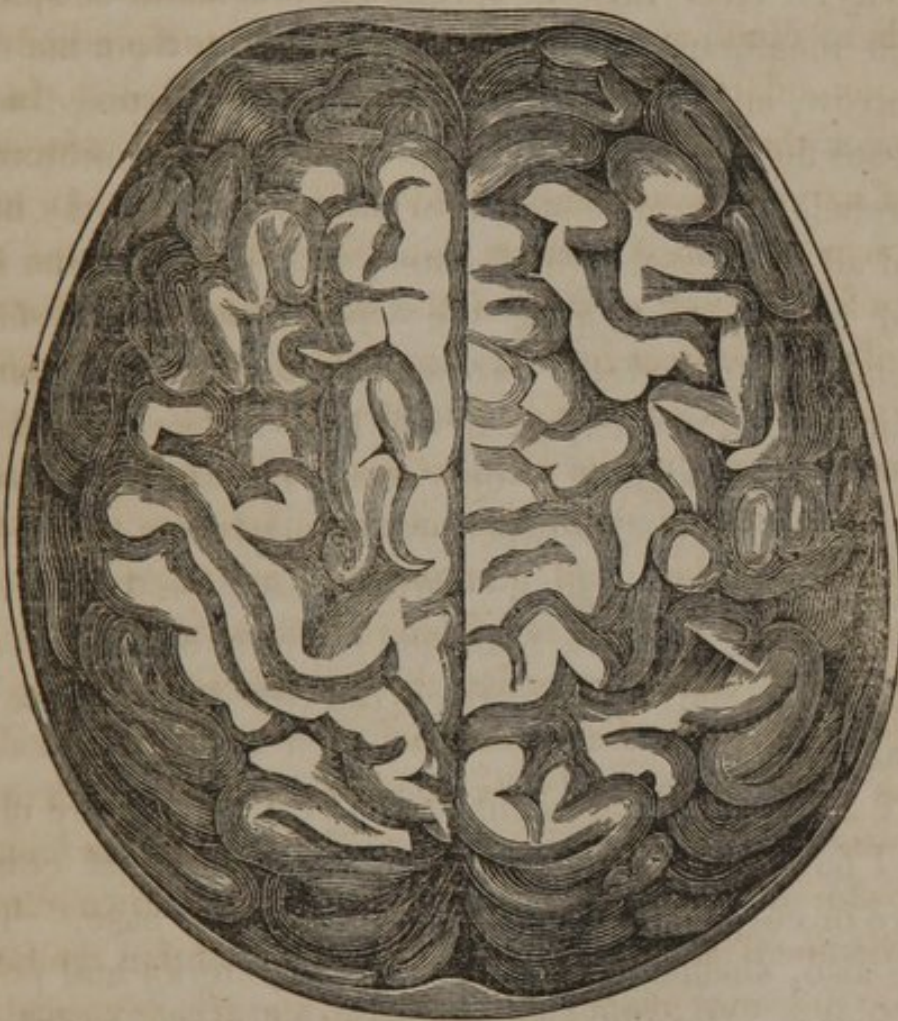
(fig. 15. A) from the medulla oblongata to the ganglions, and from the ganglions to the great commissure.

§ 271. According to Tiedemann and to my own convictions then, when the cerebral hemispheres are as fully developed in the extended membranous, or bladder-like form as the normal capacity of the skull will allow, the membrane, now consisting of the fibrous arrangement of the white substance, with a thin covering of gray substance on the external surface, begins to gather into folds so as to continue the enlargement of its surface and still accommodate itself to the capacity of the skull. In this manner the development of the hemispheres proceeds, till a nervous membrane is folded up in the cranial cavity, the area of whose surface, is several times greater than that of the inner surface of the skull; and until that thin membranous arrangement which at first, was expanded and smooth, is so closely folded upon itself, and by the general curving of the mass to adapt itself to the capacity and shape of the skull, the internal parts are so closely pressed together and compacted, as to give to the external surface of the hemispheres, those elevations and depressions which are called the convolutions, and to the medullary matter, the appearance of a thick solid wall or mass. By the general curving of this wall, also, in order to come into the spherical shape of the skull, the corpus callosum or great commissure is brought down on the middle line near to the base of the brain, and thus are formed, by the same disposition of parts, the great external fissure extending from the forehead to the occiput, between the two halves of the brain, (fig. 19.) and the great internal ventricles or cavities of the hemispheres. Other smaller cavities are likewise formed at, and near the centre and base of the brain by the relative position of different parts. But as the minute description of them

would serve in no degree to illustrate any known physiological principles, I shall say nothing more concerning them.

§ 272. Each hemisphere of the brain thus developed is subdivided, in the descriptions of anatomy, into three lobes.—An anterior lobe lying in the forehead,—(fig. 18. *a*) a posterior lobe lying in the back part of the

Fig. 19.



Top of the brain showing the convolutions, and the fissure between the two hemispheres.

head and over the little brain, (*k*) and a middle lobe lying in the region of the ear. (*b.*) Each of these lobes again, is composed superficially of a number of apparent convolutions of the cerebral substance, so that, the whole

external surface of the brain is a succession of irregular elevations and depressions: and this irregular or uneven surface, it will be remembered, is everywhere covered by a thin layer of the gray substance. (Fig. 19.) The vascular membrane called the *pia mater*, which surrounds the spinal marrow (§ 239.) comes up and expands over the little brain and brain proper, adhering in all parts closely to the surface and dipping into every depression, fissure and cavity. Over this, is spread the arachnoid or spider's-web membrane which also continues up from the spinal marrow, and is everywhere constantly moistened with a serous fluid; and which beside covering the cerebrum and cerebellum, forms a sheath or envelope for all the nerves and all the vessels which enter, or issue from the skull: and finally, enveloping the whole, the strong fibrous membrane called the *dura-mater* continues up from the spinal canal, and expands, and lines the inner surface of the skull throughout,—dips down, by what is called the falciform process, between the hemispheres of the brain to the corpus callosum,—forms a partition between the posterior lobes of the brain and the little brain, called the tentorium, and also separates the two lobes of the little brain.

§ 273. The two hemispheres of the brain are united, as I have said, on the middle line by the great commissure or corpus callosum which lies near the base. There are also, smaller commissures in the anterior and posterior parts. But the principal bond of union, and that on which the unity of the brain and of its functions, as a single organ, or as a single system of organs, mainly depends, is established at the focal point at, or near the top of the medulla oblongata, from which the fibres composing the legs of the brain, rise and diverge. “The corpus callosum,” says Dr. Spurzheim, “may be split

through its entire length, without destroying the unity of function of the two hemispheres."

§ 274. The fibrous arrangement of the medullary substance of the brain, (§ 162.) and the disposition of the fibres in the texture and general conformation of the cerebral hemispheres, have, of late years, been rendered matters of very considerable interest by the views, originally advanced by Dr. Gall, and since advocated by Spurzheim and others, concerning the relation existing between particular parts of the brain and particular intellectual and moral powers and manifestations.

§ 275. According to these views as first advanced by Gall, a certain number of medullary fibres radiating from the cerebral ganglions, in each hemisphere, form a fasciculus or bundle which proceeds to the surface of the brain and constitutes a special organ, the single and exclusive function of which, is the manifestation of a specific propensity, sentiment, or intellectual power. Of these especial organs, Gall described and located twenty-seven pairs,—including the two lobes of the cerebellum as a single pair;—the organs of one hemisphere corresponding precisely with those of the other, as one eye or ear does with the other.

§ 276. Spurzheim, who was a pupil of Gall's, embraced the views of his master with great confidence and zeal, and from that hour, devoted his whole life with untiring industry to those researches and investigations by which he hoped to erect the theory into a complete and well-established science: and if he did not live to accomplish all that he desired, he certainly succeeded in producing a powerful impression on the intellectual world, and in convincing thousands of the correctness of his doctrines. He was probably more successful in unfolding the brain, and did more to introduce a correct mode of

dissecting and studying that important organ than any other man. But such is the softness of the cerebral substance and the delicacy of its tissue, that it is impossible, by any artificial means to push our inquiries very minutely into the details of its intimate structure and arrangement, with an entire certainty of ascertaining the truth on every point. Hence, notwithstanding the confidence with which Spurzheim insisted on the existence of an order of converging fibres which originate in the cerebral convolutions and terminate, mainly in the corpus callosum, and declared that "nothing is more easy than to prove this by dissection," yet all his followers have been obliged to receive this purely as a matter of faith, for no one, I believe, has been able to demonstrate the truth of the statement. The course pursued by Tiedemann is therefore, a far more correct and sure way of coming at the truth, in regard to the intimate texture of the brain. He carefully watched the cerebral development, in all its stages, from the first appearance of any of its parts, to its full maturity. He saw the several parts in their rudiments,—saw them in their more advanced state,—saw the thin membranes of the hemispheres before they were united to the corpus callosum,—saw them when partially, and when completely united,—saw the two hemispheres when thus united, expanded and smooth like two distended bladders lying side by side,—saw them when they first began to gather into folds and saw them when closely folded in the full-formed brain. Yet even in this mode of investigation, it was possible for him to be deceived in regard to the origin and disposition of some of the parts:—but the probability of error in this mode, is incomparably less than in that pursued by Spurzheim.

§ 277. I have already presented Spurzheim's descrip-

tion of the cerebral convolutions, and of the manner in which they are formed. (§ 266.) But if Tiedemann is correct in regard to the membranous arrangement of the medullary fibres, and of the folding of that membrane so as to form what are called the convolutions of the hemispheres, in the manner I have described,— (§ 271.) and that he is correct, I must still insist, is fully proved by the complete unfolding of the brain into its membranous form, in some cases of hydrocephalus—then Spurzheim was in error not only in regard to the existence of an order of converging fibres, but also in regard to that arrangement of the diverging fibres which he describes in speaking of the formation of the convolutions.

§ 278. But if it were fully demonstrated that Spurzheim was in error on both these points, it would not necessarily follow that his theory concerning the relation between certain parts of the brain and certain powers of the mind, is incorrect. The truth of this theory is not to be demonstrated by cerebral anatomy but by cerebral physiology: and it is equally possible for such physiological powers to be possessed by the brain whether its organization is according to the descriptions of Spurzheim or those of Tiedemann.

§ 279. I have said that Gall described and located twenty seven pairs of cerebral organs. To these Spurzheim added eight pairs, which he described and located; and conjectured two pairs more, the location of which he only suggested. So that, according to Spurzheim, we have thirty-five, and perhaps thirty-seven or more pairs of cerebral organs appropriated to the propensities, sentiments and intellect. The two pairs conjectured by Spurzheim have with more confidence been described and located by some of his followers:—and indeed, some of the more bold and zealous phrenologists multiply and

locate organs *ad libitum*, to suit their convenience,—to meet their exigencies, or according to their convictions from observation. The character and location of these organs I shall describe according to the views of Gall and Spurzheim when I come to treat of the physiology of the brain. (§ 544.) It may be well however, in this place to say that phrenologists, so far as I am informed, are not decided in opinion, whether the thinking power of the brain belongs more especially and intimately to the gray substance of the surface or to the white medullary fibres which form the convolutions. (§ 161. 162.)

§ 280. From the view which I have presented of the cerebro-spinal system, it will be perceived that all the nerves of the trunk and extremities, appear to converge as it were, toward the head of the medulla oblongata; (§ 251.) and all the nerves and medullary fibres within the cranium converge towards the same point. (Fig. 16.) All the parts above this point may be destroyed by slow disease, without destroying the power of animal sensation and of voluntary motion:—and all the parts below the medulla oblongata, may be paralyzed by disease without immediately abolishing the intellectual powers. It may therefore, be asserted with great confidence, that the grand centre of animal life is at, or near the top of the medulla oblongata. I do not, however intend to imply that vitality peculiarly resides at this point; but that here seems to be such a focal point of the whole nervous machinery of the cerebro-spinal system, that we can at this place put our finger on the whole at once, and instantaneously arrest all the functions of this system of nerves. It is therefore the centre of animal perception and of voluntary action:—the point to which all animal sensations are directly conveyed, or by which they are perceived; and from which, all the mandates of volition are transmitted directly to the muscles of voluntary motion.

§ 281. I have already more than once alluded to the duplicate form of all those parts in the human body which belong to animal life.—(§ 238.) If the body be divided on the middle line, it will be found to consist of two precisely corresponding halves.—The bones, the muscles and the nerves of one side correspond almost exactly with those of the other.—The parts uniting on the middle line are composed of two corresponding halves, as the tongue, the nose, the mouth, &c., while those removed from the middle line are in corresponding pairs—as the eyes, the ears, the upper and lower extremities, &c. The nerves of the two halves of the cerebro-spinal system are very exact and symmetrical in their resemblance to each other.—The right and left half of the brain and spinal marrow and all the nerves connected with them, are almost precisely alike. Yet it is an interesting fact that this symmetry is less perfect in man than in the animals below him.—“Considered either in regard to symmetry or structure,” says Meckel, “the nervous system of man is less regular than that of other animals, even those which are nearest to him. In fact the halves of the nervous system correspond more perfectly, in the mammalia, and the deviations from the normal state in those animals, are rarer than in man.” This difference is very certainly not an aboriginal one, but is most unquestionably a degeneracy in the human species: and without doubt, has resulted from the voluntary habits of man.

§ 282. In the domain of organic life, though there is some approach to the duplicate form, yet there is no regularity or symmetric correspondence. The two lungs do not exactly correspond, nor do the two halves of the heart. Indeed there is an evident oneness of system and economy in the domain of organic life.

§ 283. We have seen that this system of nerves pre-

sides over all the vital functions by which the body is formed and sustained; (§ 218—231.) and that the nerves of animal life with their muscles, bones, &c. are purely organs of external relation; whose office it is, to perceive those external wants, the supply of which, requires their exercise, and to perceive and procure those external materials by which the internal wants are supplied. (§ 233.) These important functional relations make it necessary for the two systems of nerves to be so connected that the requisite media of communication shall be established between them: and the mutual dependencies of the two systems also require them to be intimately reciprocal in sympathy. I shall therefore now proceed to speak of these CONNEXIONS AND SYMPATHIES.

§ 284. It will be recollected, that, when treating of the nerves of organic life, I spoke of a range of ganglions lying on each side of the back-bone— (§ 220.) connected by intermediate cords, and extending from the base of the skull to the lower extremity of the spinal column;—and that these ranges are connected with the great centre of organic life, by numerous cords radiating from that centre and terminating in many of these peripheral or limiting ganglions.—Of these ganglions, there are usually on each side, three in the neck, twelve in the region of the back, five in the region of the loins and three or four in the sacral regions. These ganglions lie near where the spinal nerves of animal life are connected with the spinal marrow: and as the spinal nerves pass by the ganglions, each ganglion gives off two branches which proceed outward a short distance, and join the corresponding spinal nerve. (Fig. 14. z.) One of these branches is usually larger and more pulpy than the other and sends some twigs to the muscles between the ribs. This is supposed to be more especially the

medium of communication from the ganglion to the spinal nerve: and the other, which is smaller, whiter, and gives off no twigs, is supposed to be the medium of communication from the spinal nerve to the ganglion. All the ganglions in the two ranges, also give off filaments which go with the nerves of animal life to the muscles of voluntary motion:—and more especially to those voluntary muscles which are concerned in the function of respiration. The highest ganglion of the range on each side, lies at the base of the skull and sends a branch upwards which dividing into twigs, forms a kind of plexus around the main artery of the brain, and passing with it into the cranium, unites with two or three cerebral nerves and particularly the trifacial, which is so important a nerve of the head. This last nerve also, it will be remembered, after passing out of the cranium, unites in its various ramifications extensively with the nerves of organic life. (§ 254.) Such are the connexions between the limiting ganglions of organic life and the nerves of animal life.

§ 285. The upper central connexions are mainly established by the pneumogastric. This nerve, it will be remembered issues from or near the grand centre of perception and action, of the nerves of animal life, (§ 245.) and by its branches forms connexions with almost every nerve, both animal and organic, in the region of the throat and neck, and also forms extensive connexions with the nerves of organic life in the thoracic cavity;—and unites freely in the stomach with the nerves coming directly from the great centre of organic life, and finally sends some twigs directly to that centre itself. (§ 247.)

§ 286. Another, and more extensive and general connexion is formed between the two systems of nerves, by that arrangement on which the body in all its parts and

tissues depends for sustenance. The nerves of organic life appropriated to the vascular system, and which preside over all its varied functions, penetrate with the vessels to which they belong, into every structure of the body.—Even the brain and spinal marrow, and all the nerves of the body, are nourished by blood-vessels over whose functions the nerves of organic life preside. By this universal presence and functional relation the nerves of organic life are brought into important connexions with those of the cerebro-spinal system. This species of connexion is largely formed in the extended membrane which constitutes the covering of the body, and therefore for the sake of showing still farther the anatomical connexions and functional and sympathetic relations between the domains of organic and animal life, I shall introduce in this place a general description of the skin, reserving the more minute details, till I come to speak of its particular functions.

§ 287. In the vegetable kingdom, there are some species, which may be torn up by the roots and inverted—placing their tops downwards in the earth and their roots in the place of their boughs, and the order of their vegetation will change, and their tops will become roots and their roots, boughs with their twigs, leaves, &c. So in the animal kingdom there are some species which may be turned inside out, and they will live on, apparently as well as before;—the membrane which was internal performing all the necessary functions of the external—and that which was external performing all the necessary functions of the internal skin. This correspondence of anatomical structure and functional capability between the inner and outer skin, is continued to a considerable extent through the whole animal kingdom, up to the human species. In man, a peculiar membranous texture of cellular tissue covers the whole external surface of

the body like a sack:—continuing over the lips and up the nostrils, the same membrane lines the cavities of the mouth and nose, covering the tongue, &c.—and still continuing backward, and downward, it covers and lines all the parts of the throat—lines the windpipe and extends through all its innumerable branches in the lungs—lining all the air-passages and cells, and presenting to the air in the lungs an extent of surface equal to the whole external skin of the body; and some think, much greater. The same membrane, also continues down the meat-pipe, lining it and the stomach and the whole intestinal canal and the ducts which open into it. This membrane throughout its whole extent, is a delicate net-work, with an almost infinite number of extremely small meshes.—Through these meshes penetrate in countless numbers, the almost inconceivably minute terminations of capillary vessels of the sanguiferous and lymphatic systems, with their accompanying and presiding nerves. Besides these, innumerable filamentary extremities of the nerves of sensation, pass through the meshes of the membrane in the same manner. These vessels and nerves are so minute, so numerous and so intimately associated that it is not possible to puncture the skin in any place, with the point of the finest needle, without wounding both a nerve and a blood-vessel. According to some anatomists, this vasculo-nervous web is so constructed as to form a kind of nap on the exterior face of the membrane somewhat like the pile upon velvet. This nap however, and particularly that portion of it which consists of the nerves of sensation, is longer and thicker in some parts than in others; (§ 242.) as on the ends of the fingers, &c. externally, and in the stomach and small intestines internally. To lubricate these exquisitely delicate little organs and preserve them in a condition proper for the performance

of their functions, they are everywhere surrounded by or imbedded in a thin body of mucus. This, on the external surface is called the rete mucosum; and contains the substance which gives the color to the skin;—being black in the negro—copper-colored in the Indian, white in white people, &c. Still farther to protect these delicate little organs from the rude and improper contact and influence of external things, the whole external surface is covered with a thin transparent, horny substance called the epidermis or cuticle. This however, becomes very thick and hard on parts subjected to much friction, as the bottoms of the feet, the palms of the hands and insides of the fingers of laboring men, &c. On the lips, nostrils, &c. where the external skin fades into the internal, the cuticle is extremely thin. In some animals a very delicate epidermis or cuticle, continues inward lining the mouth, meatpipe and stomach; and some anatomists have supposed this to be the case in man.*

§ 288. We see then, that the external surface of the body, and the cavities of the mouth, nostrils, windpipe, air-passages and cells of the lungs, meatpipe, stomach, intestinal tube, &c. constitute the confines of the incorporated living system, through which it communicates with the external world; and all these surfaces are covered by the same continuous, delicate, net-like membrane, through which must pass every thing that enters into, or issues from the living system. And for the purpose of introducing into the system all materials necessary to sustain the vital economy, and of conducting from it all that the vital economy has no further use for,

* Doctor Horner, of Philadelphia, has recently demonstrated the existence of an epidermis throughout the whole length of the alimentary canal, of which I shall speak more particularly when I come to describe the particular anatomy of the parts.

or that would clog, or oppress or disturb or destroy the operations of the economy, the innumerable vessels which I have just named, pass through the meshes of the membrane and form a vascular web upon its exterior face; and with these also, the myriads of most exquisitely delicate feelers, whose office is with strictest integrity to give their respective centres of perception and action, all necessary information concerning the presence and qualities of external things, with reference to the interests of the vital economy.

§ 289. In regard to the substances conveyed into the living system, the little vessels differ in function, in the different parts of the internal and external surface, as we shall see hereafter; and this is also true, concerning the substances conveyed out of the system. Still however, there is, to some extent, a general correspondence of function throughout the whole confines of the living system;—and especially, the eliminating functions, or those which convey substances from the body. The external skin and that of the lungs and alimentary canal, in many respects very nearly resemble each other, in regard to the substances which they throw off from the system; and they are, to a considerable extent reciprocal, or vicarious in their offices—the excess of one corresponding with the suppression of another.—The internal skin which lines the mouth, nostrils, windpipe, meatpipe, stomach, intestinal tube, &c. is, in the descriptions of anatomy and physiology, called the mucous membrane.

§ 290. The myriads of little *feelers* or filamentary extremities of the nerves of sensation in the external skin are nerves of animal life and are connected with the back portion of the spinal marrow, (§ 242.) and through it, with the top of the medulla oblongata and brain.—Those of the internal skin or mucous membrane, are nerves of

organic life (§ 230.) and are connected with their special centres of perception and action, and through them with the grand centre of organic life. (§ 226.) The nerves of animal sensibility also extend to all portions of the mucous membrane which line or cover parts subject to the control of the WILL or which perform voluntary functions, as the mouth, throat, &c.

§ 291. Thus we see that the skin, as a whole, constitutes a very extensive medium of connexion and functional relation between the nerves of organic, and those of animal life; and the sympathetic relations and reciprocities are equally direct and powerful. The mucous membrane of the alimentary canal and lungs sympathizes directly and powerfully in all the irritations and affections of the external skin;—and the whole external skin in turn, sympathizes in all the irritations and affections of the mucous membrane: this is particularly the case in all morbid affections of the external and internal skin.

Organic and Animal Sensibility.

§ 292. I have often spoken of organic and animal sensibility. It is very important that the meaning of these terms should be fully understood.—Strictly speaking, there are several species of sensibility in the human body.—That vital property of the muscles which renders them susceptible of the action of their appropriate, and other stimuli, may be considered a species of organic sensibility, but it is generally called irritability; and the term sensibility is only applied to the nerves. To make this deeply interesting subject as plain as possible, it is necessary that I should recapitulate for a moment. I have said that the large nervous mass lying back of the pit of the stomach, is the great, primary and common

centre of organic life, and that the numerous smaller masses, or subordinate brains, are the special centres of particular organs or apparatuses of organs,—(fig. 14. *a. o.*) and that the top of the head of the spinal marrow is the centre of the nerves of animal life, or the centre of the nerves of external relation. Fig. 16. M.

§ 293. Now let us understand the extent of the functional powers of these several centres.

In the first place, the special centres of organic life (§ 219.) preside over the functions of their particular organs; and so far as each particular function is isolated from the functions of other organs, the centre which presides over it, is an independent and sovereign centre of perception and action:—but so far as it is immediately associated with the function or functions of other organs, the presiding centre is confederated with other special centres: and so far as each function is related to the great common centre as a constituent part of the common whole of organic life, each special centre is subordinate to the great common centre: and so far as the COMMON WHOLE of organic life requires the exercise of the organs of external relation, it is in a manner, subordinate to the centre of animal life. The functional powers of this last centre then, are, first, the perception of the wants of the internal system as a whole; such as the want of air, food—drink, &c. second, the perception of the external materials and means by which the internal wants can be satisfied: and third, the exertion of that influence by which the voluntary muscles are contracted, and the motions are performed, necessary for supplying the internal wants.

§ 294. We see then, that when there is a general state of health throughout the body and all things in the vital domain are as they should be, and every function

properly performed, the special centres only, have perception of what is taking place in their own appropriate spheres, while the great common centre has perception of the general condition of each particular organ, and presides in a general manner over the whole domain of organic life. The centre of animal life therefore, has no perception of, nor control over the particular functions of organic life. It only has cognizance of those general wants of the internal system, which, though referred to particular organs, are still the common wants of the whole system. The functions of the stomach, intestinal canal, liver, pancreas and all the other organs within the exclusive domain of organic life, are, in a state of perfect health and good order, no more perceived by the centre of animal life, than they would be if they belonged to another distinct individual animal. (§ 228.) Hence we say that the nerves of organic life have no animal sensibility.—They may in a state of health, be touched, cut or lacerated, and the animal will suffer no pain, because the centre of animal perception has no consciousness of the act.—But the performance of the functions of external relation, over which the centre of animal life presides, requires that this centre should have an extensive perception of external things with all their qualities and conditions. The qualities of density or resistance, heat, cold, &c. &c. must be *felt* by the animal. Hence a part of the nerves of animal life (§ 242.) are endowed with the vital power of conveying to the centre of animal perception the impressions of touch, heat cold, &c.; and as the things and qualities in relation to which this sense exists, may annoy and injure the body in every part, the sense is universal in the domain of animal life. The whole external skin is largely supplied with nerves which constitute it a general organ of touch. The

limits of the internal skin, and the muscles or flesh generally, also receive a measured supply of these nerves. That property or power of the nerves of animal life then, which enables us to feel heat and cold, and to know when any thing wounds or touches us, and to perceive the qualities of hard, soft, rough, smooth, &c. &c. &c. is what is usually called common animal sensibility: and the exercise of this power, or the pleasurable and painful feeling excited in these nerves by contact or otherwise, we call animal sensation.—This I have said (§ 242.) is the fundamental faculty of external relation, and in some degree is always present when animal life exists. It is a specific power which gives the centre of animal life the perception of certain qualities of external things, and is as truly a special sense as any in the body. (§ 253.) But there are other qualities of external things which exist in relation to organic life, that are not perceived by this sense or power. For the perception of these, therefore, the animal is endowed with other special senses or faculties of external relation. The first of these—and that which comes nearest to the sense of touch, and is perhaps most intimately associated in organization with it, is the sense of taste, (§ 254.) by which the animal perceives certain qualities of external things which relate to the alimentary wants of organic life, such as sweet, sour, bitter, &c. &c. The next, in the order of its functional character, is the sense of smell, (§ 252.) by which the animal perceives certain other qualities of external things which relate to the alimentary and respiratory wants of organic life; such as the various agreeable and disagreeable, salutary and baneful odors. The sense of hearing and the sense of sight, are faculties established not only in relation to the wants of organic life, but, to the general interests and welfare of the body as a whole; and in man, these two

faculties are more extensively and eminently the instruments of the soul, in the performance of its higher functions.

§ 295. Now let it be distinctly remembered, that each of these senses or faculties of external relation, is a power by which the centre of animal life perceives certain qualities of external things;—and that the peculiar vital endowments of each organ of special sense precisely fit it for the perception of those particular qualities, in relation to which it is established; and therefore these faculties are never vicarious in their functions. (§ 253.) The eye never hears, the ear never sees, &c. The eye is only fitted to appreciate the properties of light, the ear of sound, the nose of odors, the tongue of taste, and the fingers and external skin universally, the tangible properties.

§ 296. With these explanations of animal sensibility, or the powers of external perception, let us return to the domain of organic life; and there—though we find no animal sensibility, yet we shall find the rudimental prototypes of all the external senses,—each organ possessing an organic sensibility as exquisitely delicate as the special sensibility of the nose or ear or eye;—and as perfectly fitted to perceive and appreciate the qualities of things in relation to which it was constituted by a wise and benevolent God, as either of those special organs.—Organic sensibility then, as a general property, is the power of the appropriate nerves of organic life, to receive and convey to their special, or general centres, the impressions made upon them by the substances contained in the organs to which they are distributed:—but this sensibility has nice and important shades of difference in the different organs, adapted to the constitutional purposes of each particular organ. Thus;—the organic sensibility of the

stomach is adapted to the properties of the food designed for the nourishment of the body; and the organic sensibility of the intestinal tube is adapted to the properties of the chyme, &c.—that of the lacteals, to the chyle—that of the arteries, &c. to the blood—that of the biliary vessels to the bile, &c. &c. But this very adaptation of the nerves of organic sensibility to the properties of appropriate substances unfits them for the presence of improper substances; and consequently, when such substances are introduced into the stomach and other organs, they are the causes of irritation, disorder and disease; and, in a natural and healthy state, always in proportion as they are unadapted to the peculiar sensibility of the organ and unfitted for the supply of the vital wants, or are of a character unfriendly to the vital interests.

§ 297. In regard to the sympathetic relations of parts, there is a very considerable difference between the nerves of organic and the nerves of animal life. The organs of animal life, so far as their sympathetic connexion depends on the cerebro-spinal nerves, are comparatively isolated. A hand or a foot, an ear or an eye, or even a lobe or hemisphere of the brain may be diseased and destroyed, and the corresponding, and other organs of animal life, will suffer very little direct sympathy. But in the domain of organic life, all parts sympathize with each, and each with all. If the stomach, in a healthy state of itself and of the whole system, receives a portion of food which is perfectly adapted to its peculiar sensibility and to the real wants of the vital economy—it is healthfully excited, and its general condition is agreeable, and all the other organs sympathize directly in the general condition of the stomach, rejoicing with it, and performing their own functions with a livelier and more gladsome energy:—and on the other hand, if, by the ingestion of an improper

substance or any other cause, the stomach is irritated or disturbed to an extent which affects its general condition, all the other organs sympathize in that condition, and their functions are commensurately disturbed,—being either accelerated or retarded in an unhealthy and injurious manner.

§ 298. In the same manner also, all the other organs sympathize with the intestinal canal, with the liver, kidneys, &c. &c. But the degree of sympathetic influence which each organ has on the others, is always proportionate to the functional importance of the organ in the system and the nearness of its nervous relation to the great centre of organic life. Hence the stomach holds an immensely important station in the assemblage of vital organs. Supplied as it largely is with nerves, directly from the great centre of organic life, (§ 231.) and with the pneumogastric, from the centre of animal life, (§ 245. 285.) and associated by plexuses with all the surrounding organs, it sympathizes more directly and powerfully with every other internal organ, and with every part of the living body, than does any other organ:—and in turn, every other internal organ and every part of the living body sympathize more directly and powerfully with the stomach than with any other organ.

§ 299. But notwithstanding the organs of animal life have very little direct sympathy with each other, yet, inasmuch as they depend on the nerves of organic life which belong to the blood-vessels that enter them, for their continual sustenance and healthy condition, they sympathize very directly, and in a diseased state, very powerfully with the internal organs; and particularly with the stomach.—If the eyes, ears, hands, feet, or any other part belonging to animal life, be diseased, every disturbance, irritation, or oppression of the stomach, aggravates

that disease; and chronic indigestion always impairs the tone and functional power of the whole external skin, and indeed of the whole living system.—Few things, it is well known, will more speedily and completely prostrate the muscular powers of even the strongest men, than high irritation in the alimentary canal. On the other hand, the internal organs sympathize very directly with those of animal life. The continued action of excessive cold upon the external skin, retards all the internal functions: and so also, the continued action of excessive heat on the external skin debilitates the stomach and other internal organs and always tends to cause indigestion, pulmonary disease, &c. In short, every external affection has some sympathetic influence on the internal organs, and especially the stomach and alimentary canal generally:—the liver, lungs, kidneys, &c. are also intimately involved in this sympathy. But of these reciprocal sympathies between the organs of organic and of animal life, perhaps the most powerful at all times, is that which exists between the stomach and the brain. A severe blow upon the head will cause nausea and vomiting; and all degrees of irritation in the brain, proportionably affect the stomach; and on the other hand, certain irritations of the stomach will cause vertigo of the brain, or a derangement of the functions of the brain, or even a total suspension of its functional powers:—and all degrees of irritation in the stomach, which affect its general condition, proportionably affect the brain. And let it be remembered also, that in all the sympathetic as well as idiopathic, or original irritations of the stomach, the liver, intestinal tube and other internal organs sympathize.

§ 300. This wonderful economy of sympathy, which, in a well regulated state of the living system, is admirably adapted to the purposes of vitality, and is exceedingly

conducive to the enjoyment of the animal, may, by long abuses of the system, be converted into the source of the most intolerable suffering. In a healthy state of the system, if any improper substance be brought within the precincts of vital action, the part with which the substance comes in contact, perceiving, by its organic sensibility, (§ 296.) the deleterious character of the substance, gives alarm to its centre of perception and action and that centre takes immediate measures, by increased secretions, &c. to shield its special domain from the pernicious effects of the substance. And if the quality and quantity of the substance be such as to endanger seriously, the vital interests of the whole system, the special centre gives alarm to the great common centre of organic life, and thence it is spread throughout the whole domain; and all parts sympathize with the suffering organ, and, by a general consentaneousness of action, strive together to remove the offending cause:—and when the emergency is great, and the danger imminent, the agonizing energy of organic life is poured upon those muscles of animal life concerned in respiration, and violent vomitings, &c. ensue. In all these operations the organic instinct acts determinately, and as it were, rationally, with reference to a final cause of good, viz. the removal of the offending cause. But if the disturbing cause be too long continued, or too frequently repeated, the organic sensibility of the part becomes diseased, and excessive irritability is induced: and if the part be an important one, such as the stomach or intestinal canal, the diseased irritability is soon propagated throughout the whole domain, and a highly morbid sympathy is universally established. In such a state of things, the organic instinct when agonizing with irritating causes, frequently acts with most fearful insanity, pouring its misdirected energy on parts whose action cannot afford

relief, and terrible spasms and general convulsions are produced.—These effects are generally attributed to the irritations of the brain. But I am convinced that this is a capital pathological error and that it has been the source of immense error and evil in therapeutics. The brain undoubtedly *may be* the primary seat of those irritations which cause spasms and convulsions, but this is not necessarily the case. Epileptic and other convulsive fits and spasmodic affections, almost universally result from irritations in the domain of organic life; and the alimentary canal is most generally the primary seat of those irritations. When the irritations and convulsions are long continued, the brain becomes sympathetically involved and often suffers most ruinously—even to the entire derangement, or total abolition of its functions, and decay of its substance. Yet, how often do we see the most terrible spasms and convulsions where there is not the slightest symptom of cerebral irritation?—proving that the morbid irritations of the nerves of organic life, can be transmitted directly to the muscles of animal life, without the agency of the cerebro-spinal centre. The numerous branches which the ganglions, and particularly the limiting ganglions on each side of the back-bone, send to the muscles of animal life (§ 284.) are probably the media through which the irritations are transmitted.

§ 301. The nerves of organic life I have said (§ 294.) are, in a state of health, entirely destitute of animal sensibility, but as we have seen (§ 296.) they are endowed with an exquisite organic sensibility, which qualifies them most perfectly for the performance of their constitutional functions in the living system; and the complete integrity of those functions, essentially depends on the healthy properties of the nerves. But the organic sensibility of these nerves may, by continued or re-

repeated irritation become exceedingly morbid or diseased, and a preternatural irritability and diseased sympathy may be induced and permanently established. In this state of things, all the functions of organic life are necessarily impaired, and to an extent always proportionate to the degree of diseased irritability and sympathy of the nerves. The food is less perfectly digested in the stomach, the chyle is less perfectly elaborated, the blood necessarily becomes deteriorated and the whole system, in every part and tissue, consequently suffers. By excessive and continued irritation also, inflammation may be induced, and the most painful sensibility developed in the nerves of organic life, so that the centre of animal life will not only be conscious of the pain but refer it to the part diseased;—the same as it does impressions or affections of its own domain. This state of things is not only distressing but is always injurious to the living system and often imminently hazardous to life.—When therefore we are *conscious* that we have a stomach, or a liver from any *feeling* in those organs, we may be certain that something is wrong. For, as I have already remarked,—in a perfectly healthy state of the system we have no consciousness of individual organs within us, and no other consciousness of the domain of organic life as a whole, than such as appertains to the general wants of the vital economy, which require the exercise of the voluntary powers in supplying food, drink and air, and in the voluntary eliminations of the body. When the food is procured and masticated and swallowed, it has passed beyond the cognizance of animal life and is given up to the operations and processes of the vegetable organs, to be converted into chyme; from which is elaborated the chyle, the blood, the bone, the muscle, the nerve, &c. and all without the care or consciousness of the animal.

§ 302. Let us now, for a few minutes, contemplate

the sympathetic relations between the nerves of organic life, and the mind.

We have seen (§ 218.) that the great centre of organic life presides in a general manner, over all the functions concerned in nourishing and sustaining the body: and consequently these functions are removed from the control of the WILL. The stomach, the liver, the heart and all the other internal organs, regularly perform their functions without the agency, and beyond the direct control of the WILL.

Because it is the business of the voluntary powers to fulfil external relations and to prevent the ingress of improper substances to the lungs and stomach,—a wise and benevolent Creator, has made the WILL, as it were, a warden to those important organs. Should we find ourselves surrounded by an offensive atmosphere, or submerged in water, the WILL, by a direct control can suspend respiration for a very short time; and for similar reasons, it can exert its power directly on the apparatus of respiratory muscles, to accelerate their action. By a voluntary control of the respiratory apparatus to a necessary extent, we are also enabled to speak, sing, &c. Yet the function of respiration is properly an involuntary one, and is performed independently of the WILL. So in regard to the stomach:—the WILL must control the functions of chewing and swallowing the food: but the instant the act of swallowing is performed, the food is beyond the direct control of the WILL.

§ 303. Properly speaking therefore, the mind cannot exert the power of the WILL directly, on any organ strictly within the domain of organic life.—The ordinary, calm, and gentle operations of the mind have little, if any effect upon the nerves of organic life. But when the exercises of the mind are intense and protracted, the

whole domain of organic life sympathizes with the brain; and when these exercises are of an excited and impassioned kind, the sympathetic influence is poured with considerable energy upon the nerves of organic life, and all the functions of that domain are more or less disturbed; while at the same time, a strong emotion, or sensation of a peculiar kind, is produced in the epigastric centre; usually referred to the heart;—but the stomach, more than any other organ, is the true seat of it. Hence the function of this organ is more affected by mental influence, than that of any other: and indeed, it is in a considerable measure, through the stomach that the other organs are affected by mental influence. In all violent passions however, the whole domain of organic life, seems to be, as it were, inundated by the lava of the mental volcano, and the actions of the several organs are convulsively accelerated or retarded to a most fearful and dangerous extent: and in some instances, all the functions of life are suddenly arrested as by a lightning stroke, and death is instantaneously induced!

§ 304. All mental excitements therefore, are causes of some degree of disturbance to the nerves of organic life: and when violent, and frequently repeated, they necessarily induce, and permanently establish a morbid irritability and sympathy throughout the whole domain, generally involving also, the brain and spinal marrow; and especially the brain. Functional aberration and derangement necessarily result from this state of things, leading to disease and change of structure in the organs.

§ 305. On the other hand, the mind sympathizes in the most delicate and powerful manner with the nerves of organic life, in all their general affections and conditions.—When this system of nerves is in perfect health,

and under the influence of appropriate stimuli—such as proper air in the lungs, proper food in the stomach, proper chyle in the lacteals, proper blood in the arteries, &c. the instinctive wants of the system are satisfied, every organ performs its function with tone and alacrity, and a delightful communion of sympathy pervades the whole domain. In all this there is no *local feeling*—no animal perception of a distinct sensation *in any particular part*;—nay indeed, there is not the least animal consciousness of any internal organ. Without being conscious whence it comes, or on what it depends, the animal is simply conscious of a general, and as it were, *spiritual joy*.

And in this consciousness the playful lamb
 Skips with delight and gambols round its dam;
 The calf and colt, from their confinement freed,
 Stretch their young limbs and bound along the mead;
 The noble horse, with wildly flowing mane
 And wide-stretched nostrils, gallops o'er the plain,
 Lifts high his head, as of his freedom proud,
 Snuffs the pure breeze and snorts his joy aloud.
 And, in this consciousness, with infant glee,
 The tottering child plays round the mother's knee;—
 The older sister—though oft chid as rude,
 Yields to the spirit of her romping mood;—
 With her loved brother seeks the open air,
 And they like lambs, run, leap, and frolic there.—
 E'en full-grown man, though crippled, blighted, cursed,
 By evil habits long and fondly nursed,
 In healthier moments, still doth often feel
 Something of this pure spirit o'er his bosom steal!

The mind, in all its faculties and operations, feels the bland exhilaration, but it is not conscious of its nature, nor of its source. The thoughts flow with greater ease and increased energy,—the imagination becomes more vivid and vigorous, and the memory more clear and active.

But the mind is not at all conscious that this state of things is in any degree, connected with the condition of the body:—on the contrary, it thinks that the exhilaration is aboriginally and purely mental; and that the pleasurable feeling, results entirely from its own felicitous exercises. This delightful sympathy between the nervous system of organic life and the mind, may be preserved through life; and were all the laws of constitution and relation, which our benevolent Creator has established in our nature, properly obeyed, it would be so. While the nerves of organic life are preserved in a perfectly healthy state, the mind is habitually serene and cheerful, as in healthy childhood. Moral causes may give it pain, but as soon as the direct action of those causes ceases, it springs elastic from the oppression, like that of a little child which turns from the chidings or chastisements of a parent, to forget its sorrows and to break into the smiles of its revived enjoyment, before the tears are dried from its cheek. But when, by the continued irritations of the stomach and other organs, the organic sensibility of the nerves becomes diseased, and a morbid irritability and sympathy are gradually induced and permanently established, the mind, sympathizing with the nerves, and yet without the consciousness of that sympathy, gradually loses its habitual serenity, and by degrees, becomes shrouded, first, in the occasional and then the more constant pensiveness of early youth, and this is followed by the darker shades of youthful discontent—a deep, continual restlessness!—We are unhappy—yet we know not why.—We long for relief—but we know not what.—We would go—but we know not where!—We would cease to be what we are—yet we know not what we would be. This sickly sentimentality, tends always to a more confirmed and painful melan-

choly, from which we only find occasional relief, in the intoxications of a misguided world! and too frequently, the very means of our relief, serve to aggravate our disease, till we become completely wrapped in the black and cheerless pall of unutterable despondency.—And even they who seek relief in the faith which looks forward to a better world, too often have little other enjoyment of their existence, than that which arises from the hope of what they shall be beyond the grave: and this is often torn from them by morbid doubts and fears. In all these *painful* sympathies as in the *pleasurable* ones, the mind has no consciousness that it sympathizes with the body; but fully believes that all its sufferings are purely of a mental and moral nature; and it seeks and fixes on some object which it believes to be the cause of all its misery.—The dread of becoming poor—of losing friends—or reputation—or some other imaginary evil haunts the mind thus laboring under the influence of a diseased body,—perhaps to utter madness; and too frequently, the miserable victim rushes from the world in the anguish of insupportable despair.

§ 306. Such are the direct relations, between the mind and the nerves of organic life.—The indirect relations are numerous and important;—many of which I shall explain hereafter. All those predispositions and peculiarities which we call hereditary, are transmitted from parent to child through the medium of this system of nerves,—such as temperament, predisposition to consumption, dyspepsy and all other diseases of the body; and also the mental and moral predispositions:—for I shall show hereafter, that, admitting all that Gall and Spurzheim claim concerning the organization of the brain and its relations to the mind, still the nerves of organic life are

the media through which all cerebral peculiarities are transmitted from parent to child.

§ 307. Like the other solids which I have described, all the nerves of the body are much more soft and pulpy in early life than at a later period. In advanced age they usually become much drier, smaller, and harder. Ordinarily, in civic life, the internal ganglions with their cords begin to diminish in size and to become paler, drier and harder about the fortieth year: but the period is greatly varied by the habits of the individual.

LECTURE VII.

The Cellular, muscular and nervous tissues and their vital properties, compose the organs and endow them with functional power—Definition of tissue, organ, vessels, viscera, vascular system, capillary system, function, vital economy, &c.—Change of matter in organized bodies—They are organized and endowed accordingly—Vegetable bodies, how nourished and organized—Animal bodies, how nourished and organized—Grand function of the alimentary cavity—Masticatory organs, jaws, teeth, tongue, &c. their development, character and functions—The fibrous, serous and mucous membranes, their situation and office—The anatomy, disposition and functions of the skin and mucous membrane particularly described—Simple absorbents and exhalants—mucous follicles and glands—Mucous membrane forming the œsophagus, stomach and intestines,—Salivary glands, liver, pancreas, kidneys, &c.—Muscles of the alimentary canal—their arrangement, &c.—The peritoneal coat—Nerves of alimentary canal, &c.—Respiratory apparatus—the structure and functional purposes of the several parts—larynx, windpipe, lungs, diaphragm, ribs, &c.—Organs of circulation—heart, arteries, veins, capillaries;—their distribution, &c.—The portal system and the spleen—The lymphatics—their structure, situation and office—The lacteals—Circulating forces—Propelling power of the heart, &c.—General law of vital action

and expenditure, and flow of arterial blood—Local increase of circulation—Organs of taste, smell, hearing and sight—Hair and nails.

§ 308. HAVING given a general description of the Cellular, Muscular, and Nervous Tissues in their separate forms, and having described their vital properties, and presented a general view of the disposition of these three elementary tissues, in the formation of the living animal body, I now proceed, after a very brief recapitulation, to the consideration of the structure of the particular organs.

§ 309. The Cellular tissue, I have said, (§ 158.) is the lowest order of animal structure. It pervades every part of the body, constitutes the general frame of every organ, connects all the tissues and binds all parts together. (§ 168—171.) Its property which is called vital, because it is much greater in the living, than in the dead body, is elasticity.

§ 310. The Muscular tissue (§ 159.) is a higher order of animal structure than the cellular. Its most important property in the vital economy, is contractility. This is the element of all voluntary motion, and of most, if not all positive involuntary motion, in the living body. The muscles are divided into those of voluntary, and those of involuntary motion, (§ 194.) or those of animal and those of organic life. The former being mostly attached to the bones, and lying principally on the outside of the frame, and around the bones of the upper, and lower limbs: (§ 189.) and the latter being situated in the hollow organs composing the respiratory, digestive, and circulatory apparatuses.

§ 311. The Nervous tissue, with its important properties, relations and sympathies, I have described at large in my last two lectures. (§ 160—165. and § 202—307.)

§ 312. These three general tissues, I have said, (§ 167.) together with the more solid matter of the bones, compose all the organs and parts of the animal system, and in entering into the texture of the several organs, each tissue carries with it, and retains during life and health, its own peculiar vital properties; and these properties, viz: **CELLULAR ELASTICITY, MUSCULAR SUSCEPTIBILITY AND CONTRACTILITY, AND NERVOUS AND SENSORIAL POWER, TOGETHER WITH THE VITAL AFFINITIES, WHICH ARE UNDER THE CONTROL OF THE NERVOUS POWER, CONSTITUTE THE VITAL FORCES OF THE ORGANIC ECONOMY, AND THE FUNCTIONAL POWERS OF THE ORGANS.**

§ 213. Though these three general kinds of animal structure, are, in the language of modern physiology, called *tissues*, yet, strictly speaking, a *tissue* is a particular arrangement of fibres or filaments, in the formation of an organ. “An *organ* is a compound body, consisting of a specific arrangement of different tissues.” The internal organs are, in the descriptions of anatomy and physiology, divided into *vessels* and *viscera*. The vessels, such as the arteries, veins, lymphatics, &c. are called the *vascular system*; and the minute extremities of the arteries and veins, which, together with the lymphatics, compose a large proportion of the bulk of the whole body, are called the *capillary system*. The stomach, liver, pancreas, spleen, intestinal tube, &c. are collectively called the *viscera*, or singly, a *viscus*. A *function* is the office which an organ performs. And the **VITAL ECONOMY** consists of the general co-operation of the whole assemblage of living organs, in the performance of their several functions, to one grand result, viz. the sustenance of the body in all its organization and in all its functional powers and operations. With these recapitulations and

explanations, we are now prepared to enter upon the consideration of the structure of particular organs.

§ 314. We have seen that all living bodies are formed from the common inorganic matter of the world; (§ 49. 112. 118.) that the matter composing organized bodies, is brought into the organic arrangement and structure, by vital forces acting in and by living organs, which overcome and subdue the inorganic affinities, (§ 121.) and hold the organized matter, as it were, in reluctant obedience to vital power: and hence, the matter composing living bodies, has always a tendency to yield to the affinities, and to return to the more simple and primitive forms of inorganic matter. Hence also, as a general fact, matter is less permanent in organic, than in inorganic forms. (§ 133.) It does not remain permanently in organized structure during the life of the body but, particle by particle, is continually giving place to new matter, so that, in the course of a few years, all the matter in the human body, undergoes a change. The two great processes of composition and decomposition,—of incorporation and elimination, are therefore, continually going on in the living body. Foreign matter on the one hand, is continually assimilated and incorporated; and organized matter, on the other hand, is continually decomposed and eliminated. All living bodies are therefore, adapted in their organization, to this condition. They have organs which act on foreign matter, and assimilate it to their own nature, and organs which distribute the assimilated matter, to every part of the organic system, and organs which convert this matter into the various structures and substances of the body, and organs which decompose these structures and substances, and organs which convey the worn out and excrementitious matter from the vital domain.

§ 315. The particular organization of the different

species of living bodies, corresponds with the character and condition of the foreign matter on which they subsist.

§ 316. Vegetable bodies are nourished entirely by aqueous and gaseous forms of matter. The former, as a general fact, they derive from the bosom of the earth, the latter, from the atmosphere. (§ 208.) Hence they require no masticatory organs, and no internal cavity to contain their food, and to reduce it to the fluid state; but they send their roots into the earth, to imbibe its moisture, and extend their trunk and branches, and spread out their leaves in the atmosphere, to inspire its gases; and remain through life, fixed to the spot from which they spring, elaborating all the varieties of vegetable substance from inorganic matter, and thus preparing food for a higher order of living bodies. But animal bodies, being nourished by substances whose character and condition render voluntary powers and locomotion necessary, (§ 293.) require an internal cavity or sack to contain and digest their food, and prepare it for the action of those organs, which correspond with the roots of plants. And hence, every animal, from the zoophyte to man, has an internal cavity for the reception and digestion of its food: and this is one of the grand peculiarities which distinguish animals from plants.

Alimentary Organs.

§ 317. But though all animals are alike, in possessing an internal cavity for the reception and digestion of their food, yet they differ most widely in the construction, capacity, and general arrangement of their alimentary apparatus:—each species, being adapted in its organization, to its appropriate kind of aliment.

§ 318. In some, the alimentary organization consists of a simple sack, with a single aperture, through which, every thing it receives and evacuates, has its ingress and egress. In others, it consists of a tube or canal, of nearly equal size, in all its parts, extending directly from the mouth to the posterior end of the trunk; and having an aperture for the reception of food, and one for the evacuation of excrementitious matter.—In others again, the alimentary tube is convolved or folded, so that, its length is several times that of the body, and portions of it are greatly enlarged, so as to form what are called the stomach, the colon, &c.

§ 319. In those animals that subsist on food which is rapidly digested, and which requires a quick passage, the stomach is simple, and the alimentary tube, comparatively short, and its general capacity is comparatively small: while in those that feed on substances which contain little nutriment, and are slowly digested, the canal is comparatively much longer, and either has several capacious enlargements, or the stomach and colon are so constructed as to retain their contents a considerable time. In a third general class of animals, which subsist on a more nutritious aliment, such as the farinacious seeds, grains, roots, &c. and various fruits, the alimentary tube, as a general rule, is comparatively longer than that of the first class just described, and shorter than that of the second; but its general calibre or capacity is comparatively large, and the stomach and colon are fitted for a slow passage of their contents.

§ 320. But whether the alimentary cavity be a simple sack, or a straight tube, or a convolved canal with one or many enlargements, its grand function is always the same, viz: *converting the food into that partially assimilated substance which is called chyme, and presenting the*

chyme to those organs which elaborate the chyle from it, and conveying the fecal matter from the body.

§ 321. In regard to other portions of the alimentary apparatus, animals differ as widely, as they do in respect to the internal cavity. Some simply imbibe a liquid aliment;—some swallow substances of more consistency, which readily dissolve in the cavity, without any mechanical trituration or breaking down;—others swallow harder substances which are trituated or mashed by an internal apparatus;—and others have organs in the oral cavity or mouth, with which they masticate their food. In respect to the masticatory organs, animals differ again, very considerably. Some are fitted to tear and cut flesh into small masses, others to crop the grass and grind the woody fibre, and others to cut and mash the bulbous roots, or fruits, or other substances, which constitute the appropriate aliment of the species.

§ 322. The alimentary apparatus of man, consists of masticatory organs, a meatpipe, a stomach, an alimentary tube several times the length of the body, together with various glands, vessels, &c. &c.

Masticatory Organs.

§ 323. The oral cavity is formed by the bones of the head and face, united by cartilages, and bound together by ligaments, and invested by muscles and membranes. The upper jaw, with all the other bones of the face, except the lower jaw, is firmly attached to the skull, and only moves with the whole head. The lower jaw, is a separate bone; having somewhat the form of a horse-shoe, and is attached to the temporal bones of the skull, by a peculiar joint, which admits of a free backwards and forwards, or up and down motion, and also, a con-

siderable extent of lateral motion. These motions are performed in chewing, talking &c. by several pairs of appropriate muscles. Each jaw is composed of an external, and internal plate of dense bone, and an intermediate bony substance which is exceedingly spongy. In this spongy structure, are the cavities which contain the roots of the teeth. Before the teeth are formed, small rounded sacks are produced, in the places of the teeth. These sacks are formed of two membranes;—an outer one, which adheres very closely to the gums, and is destined to surround the roots of the teeth, as a permanent periostium; and an inner one, on which are dispersed the vessels and nerves, destined to form the tooth, and to supply its texture. Between these two membranes, is a small quantity of serous fluid. In due time, a soft gelatinous pulp rises from the base of the internal membrane, and gradually assumes the exact shape of the tooth: and, at the same time, numerous nerves and vessels are given off from the inner membrane, and distributed to the pulp or germ, which is itself enveloped by a thin vascular membrane. These vessels soon commence the work of forming the bony substance of the tooth. In the single teeth, the process of ossification begins in a single point, at the top. In the double teeth, it begins simultaneously, at the several corners or elevations, at the top. A thin shell is first formed on the outside, and then, layer after layer is added inwardly, —gradually diminishing the cavity, and reducing the size of the pulp. When the crown of the tooth is considerably advanced, the pulp throws one, two, or three branches downwards, according to the number of roots which the tooth has, and the root, or roots are formed in the same manner as the crown is. In the mean time, the vascular membrane, which envelops the germ, and which

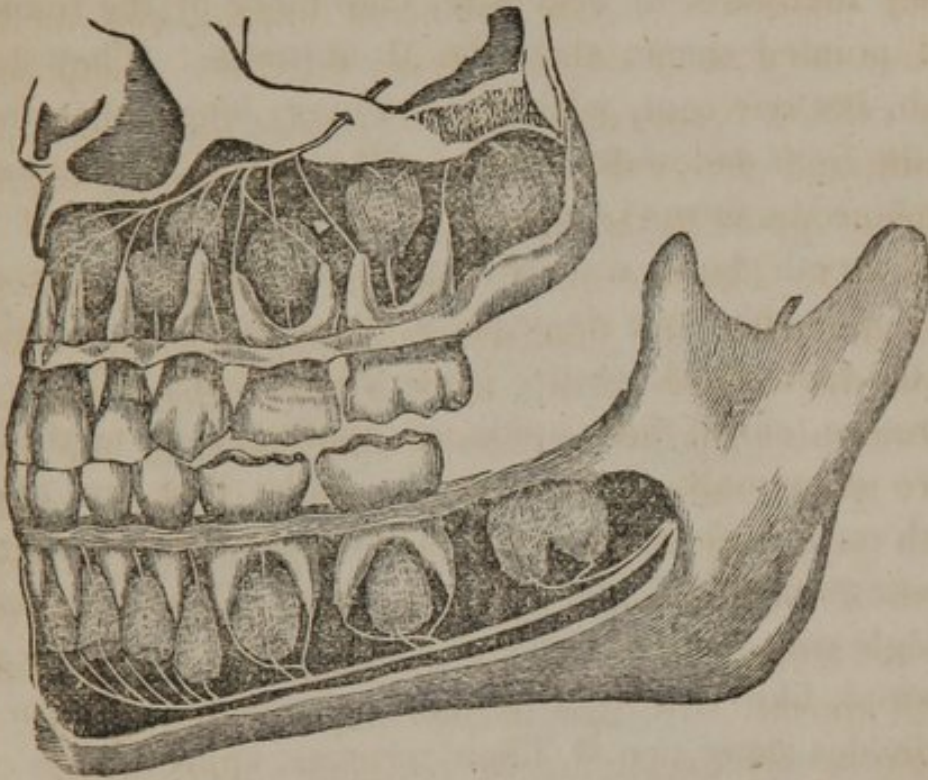
surrounds the crown of the tooth, commences the secretion of a fluid, which gradually hardens into the enamel. When it becomes necessary for the tooth to emerge from the gum, a set of vessels, called absorbents, which I shall soon describe, (§ 385.) begin their operations, and remove before the rising tooth all the superincumbent substance. The tooth, at length, lifts its body above the gum, which is a dense substance composed of the cellular tissue; and which surrounds the neck of each tooth, and covers the edges of the jaw-bones, affording a firm support to the teeth.

§ 324. The two inner, front teeth, in the lower jaw, are generally, the first which make their appearance, about the seventh month after birth. These are soon followed by the two corresponding ones, in the upper jaw; and to these, succeed the two outer front teeth of each jaw; and then follow, the first molar or double teeth of the under and upper jaws; and then, the eye, or corner teeth, and lastly, the second, or posterior double teeth appear. So that, in the course of three years, the whole twenty deciduous, or temporary teeth, make their appearance. (Fig 20.)

§ 325. When the pulp or germ, which produces the temporary teeth, in the manner I have described, is fully developed, and about to commence its process of ossification, it gives off a very small germ, or sac, formed precisely like itself in its first state, and adhering to it by a minute branch or cord. For this new germ, a cavity is prepared by the absorbents, in the spongy part of the jaw bone, where it lies carefully and securely deposited, till the jaws are sufficiently lengthened and enlarged for the development of the second, or permanent teeth. (Fig. 20.) In the present general state of the human constitution, the process of second dentition ordinarily commences

about the sixth or seventh year of life. The permanent teeth are developed in precisely the same manner, and appear in nearly the same order, as the first teeth: and as they advance in development, the roots of the first teeth in a perfectly normal and healthy state of the sys-

Fig. 20.



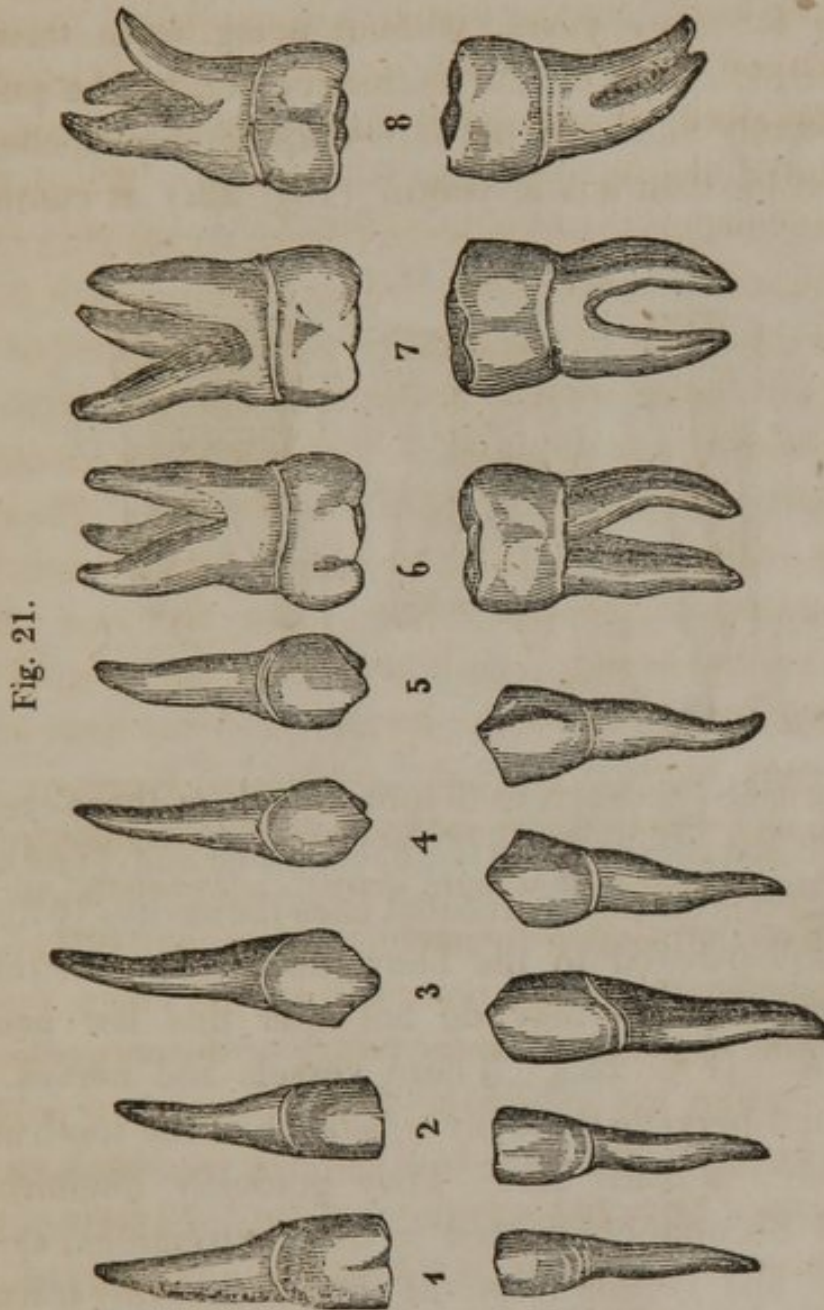
The temporary teeth, showing the germs of the permanent teeth.

tem, are gradually absorbed and carried away, till nothing is left but the part above the gums, which becomes very loose, and is easily removed. Sometimes however, in the present physiological condition of man, it becomes necessary to remove a temporary tooth by violence, before its root is absorbed away.

§ 326. The last of the permanent teeth, do not usually appear, till about the twentieth year of life; and they are therefore called the wisdom teeth. These are double teeth, and are situated in the back part of the jaws. When all the permanent teeth are developed, there are two front, one corner and five cheek teeth, in each half of

both jaws; making in the whole, thirty two.—The four front teeth, in each jaw, have single roots, and chisel-shaped crowns for cutting, and are called the incisors, (fig. 21. No. 1. 2.) The corner teeth, between the front and cheek teeth, are the first step of transition, from the chisel-shaped cutters, to the square-crowned mashers. They therefore, of necessity, take more of the rounded and pointed shape, than the front teeth. They have each, but one root, which is however, longer than those of the front and cheek teeth. Their crowns as it were, combine the forms of the front teeth and the first of the cheek teeth, being somewhat flattened like the front, and yet approaching to a single point, like one of the elevations of the first cheek teeth. (Fig 21. No. 3.) They are therefore, called the cuspids, or spear-shaped teeth: but more commonly, the eye teeth. The first two cheek teeth on each side and in both jaws, have the form of two corner teeth united by their inner faces. They have each, a single root, but it is generally, somewhat flattened and grooved, like two roots united; and in some instances, it divides into two. Their crowns approach to the square form, or oblong square, and have two elevations at the top, the one on the exterior, and the other, on the interior face, appearing like the points of the corner teeth: and hence, they are called the bicuspid, or two-pointed teeth. (Fig. 21. No. 4. 5.) The three remaining cheek teeth, on each side, and in both jaws, have the form of two bicuspid, or four corner teeth united. Those of the upper jaw, have three roots, and in some rare cases, four, which are considerably shorter, and much more divergent or spreading, than those of the under jaw, to avoid penetrating the cavities in the upper jaw belonging to the olfactory apparatus, (§ 399.) and at the same time, to give sufficient firmness to the teeth. The crowns of all these

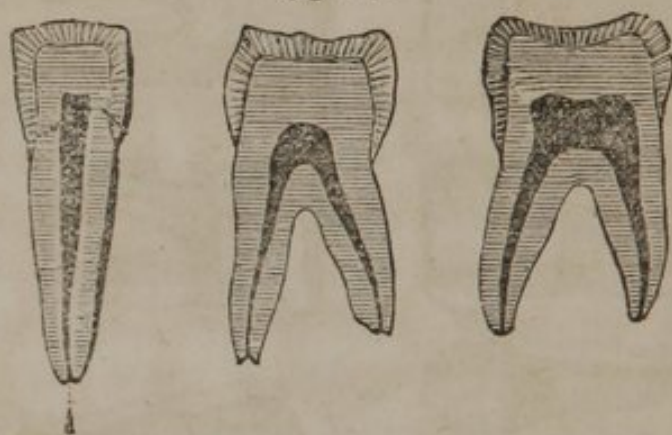
teeth, are large and nearly square, with four or five slight elevations, on the grinding or mashing face. These are called the molares or grinders. (Fig. 21. No. 6. 7. 8.)



§ 327. The bony substance of the teeth, is considerably harder than that of the other bones of the body, and contains less gelatinous matter.—(§ 169.) The enamel, which covers the bony substance of the crown or body of each tooth, and extends down to the edge of the gum, is far the hardest substance in the living body. It is indeed,

a species of *organic crystallization*. This substance does not appear to be in any manner, nourished or reproduced, in man, after the tooth is fully developed; but, being extremely hard, or dense, it sustains the friction of mastication, for many years, without being worn through. The internal cavity of the teeth occupied by the pulp is never wholly filled up: but it is considerably smaller in advanced life than it is in youth. (Fig. 22.) It continues

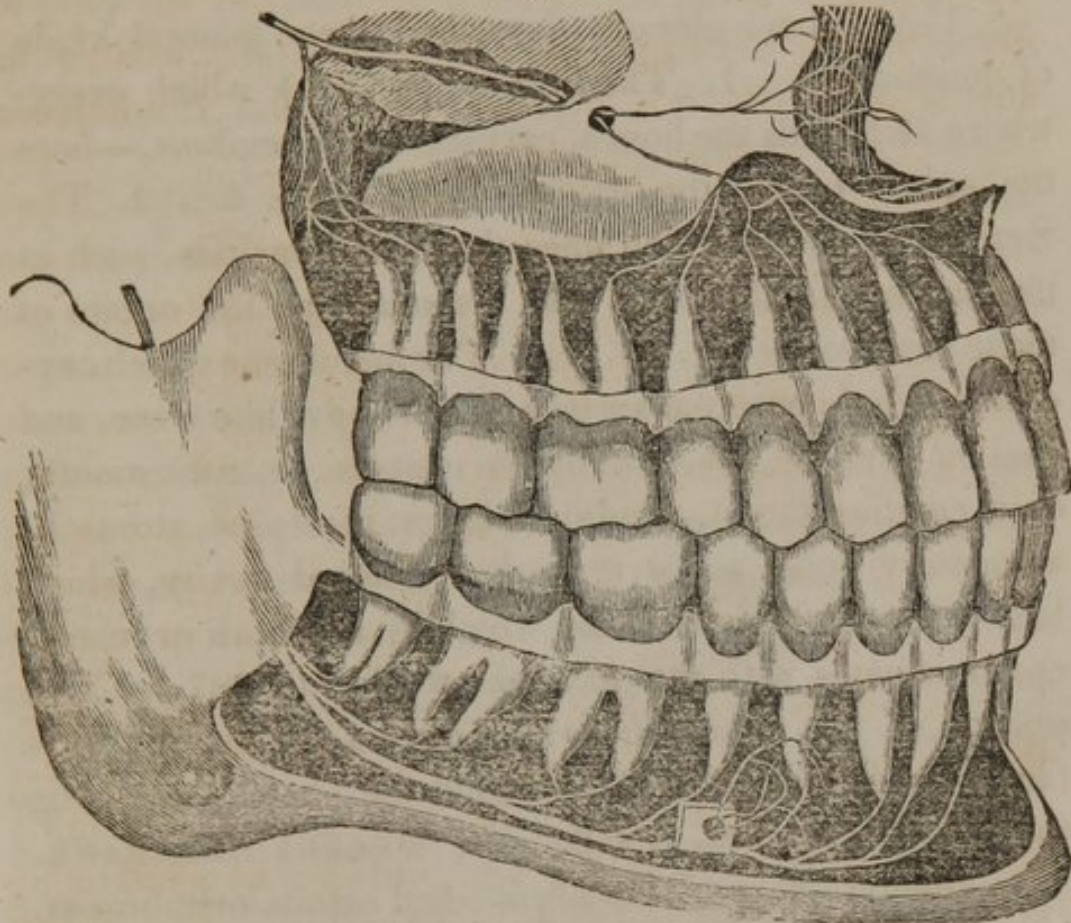
Fig. 22.



by small canals, through each root;—and, at these canals, the vessels and nerves of the teeth, enter; (§ 254.) and after ramifying upon the membrane that lines the cavity, (§ 323.) they are distributed to the bony substance; penetrating to the enamel: but they do not enter this last named substance. (Fig. 23.) These vessels and nerves are largest, and pervade the bony substance of the tooth most extensively, in early life. They gradually diminish in size, and become obliterated in their extremities, as life advances, and recede from the surface inwardly towards the central cavity. When the habits of life are not in strict accordance with the physiological laws of the body the canals in the roots of the teeth, often entirely close in old age, and the teeth are wholly cut off from vital sustenance, and then, they soon become loose, and drop out of the jaws, or their roots are removed by the absorbents.

§ 328. In the human head, the front teeth are intended to cut the food into small masses, convenient for the action of the cheek teeth, which are designed to mash or grind it finely, before it is swallowed. This process is

Fig. 23.



The permanent teeth, showing the entrance of the nerves into the ends of the roots.

called mastication: and while it is going on, other organs co-operate to prepare the food for deglutition, and to commence the process of assimilation.

§ 329. The tongue, I hardly need describe. It is composed of many different pairs of muscles, which render it capable of acting in every direction, and in almost every manner; and is covered by the mucous membrane, which lines the mouth. (§ 287.) It assists in masticating the food, by continually throwing it between the grinders

of the upper and lower jaws. It also assists in the act of swallowing it, in a manner, I shall describe when I come to speak more particularly of the functions of these parts.

Skin and Mucous Membrane.

§ 330. I have already described three general kinds of membranes. 1. The fibrous, (§ 169.) which everywhere surrounds the bones, cartilages, and tendons,—lines the spinal canal, the cavity of the skull, &c. 2. The Serous, (§ 176.) which lines the closed cavities, such as the thorax and abdomen, and surrounds all the organs of those cavities. (Fig. 35.) 3. The membrane which covers the whole external surface of the body, like a sac, and passing over the lips, and up the nostrils, lines the mouth, nasal cavities, throat, windpipe, lungs, meatpipe, stomach, alimentary tube, and every other internal cavity, which has an opening outward or which by a mouth or canal, communicates with the external world. (§ 287.) The portion of this membrane which covers the external surface I have said, (§ 289.) is called the *SKIN*: that lining the internal cavities, is called the *MUCOUS MEMBRANE*. The general office of the fibrous and serous membranes, is to cover, and line the parts to which they are appropriated, and in some measure, to keep them in their proper positions, and to furnish the cavities which they line, with a serous, glairy fluid, by which the parts that move upon each other, are moistened and lubricated; and also, to absorb whatever fluids may be introduced into these cavities.* For this kind of exhalation and absorption, they require nothing more than the minute extremities of the arteries and veins, and the lymphatics. But the gen-

* It is not a settled point, whether the fibrous membrane in any situation, performs these functions of secretion and absorption.

eral office of the skin and mucous membrane, is much more diversified, and complicated. This extended membrane as I have stated, (§ 288.) constitutes the general confines of the vital domain, and is constructed with reference to all the relations, which that domain holds to the external world; and through it, must pass, by the action of living organs, every thing that enters into that domain, or egresses from it. If pure aqueous fluid is required to enter that domain with little or no change, appropriate organs in this membrane, must absorb and convey it thither. If there be an excess of aqueous matter within the vital domain, this membrane must furnish organs to exhale, or eliminate it from the system. If nutrient matter is to enter the domain of life, appropriate organs in this membrane, must elaborate it from the contents of the alimentary cavity, by an assimilating process peculiar to themselves; and, as it were, hand it over to other functionaries of the system, to be subjected to other processes, and finally, disposed of, for the general good of the body. If mucilaginous and oleaginous substances are to be secreted from the vital domain, to lubricate the exterior surface of this membrane and protect its myriads of delicate little organs, and preserve them in proper conditions to perform their functions, or to oil the external surface of the body, to preserve the skin from the injurious action of various external agents, other appropriate organs in this membrane must secrete those substances. And if substances of a yet more exalted or complicated character, such as the saliva, the pancreatic fluid, the bile, &c. are to be secreted either for the purposes of the vital economy in carrying on its assimilating processes, or for the sake of separating excrementitious matter from the fluids of the system, and eliminating it from the vital domain, this membrane must furnish the organs for the performance of these various and wonderful functions.

Absorbing, Exhaling and Secreting Organs.

§ 331. In giving a general description of the skin and mucous membrane, (§ 287.) I said that, countless numbers, of the almost inconceivably minute terminations of capillary vessels, of the sanguiferous and lymphatic systems, pass through the meshes of this membrane, and form a close web or plexus upon its exterior surface. Some of these minute vessels, thus situated, are employed in their simple form, in absorbing such aqueous and other substances, as are at any time, permitted to pass into the vital domain with little or no assimilating change. These pervade the whole external and internal membrane; but mostly abound in the mucous membrane of the alimentary and respiratory cavities; and especially, in the stomach and alimentary tube. Others again, are employed in their simple form, in throwing off, or eliminating like substances from the system, in the state of vapor and of sensible fluids, &c. These also, pervade the whole membrane, but mostly abound in the lungs and external skin. Another set of these vessels, are employed in their simple form, in secreting the nutrient matter by which the system is sustained.* These innumerably abound in the alimentary cavity, and especially, in the small intestines. It is contended also, by some physiologists, that organs capable of performing this office, exist in the lungs and external skin; and various experiments have been made, and anecdotes told, to prove that, hunger may be appeased, and nutrition, to some extent, sustained, by the absorption of these surfaces; but nothing conclusive, nor satisfactory has been accomplished: and the utmost that

* This process is by all writers on physiology, called "*absorbing*;" but with utter impropriety. The lacteals no more absorb the chyle than the liver absorbs the bile, as will be shown hereafter. (§ 465.)

can be affirmed, is the possibility of a vicarious function of this kind, to some extent; but this is not a normal function of the parts.

§ 332. In regard to the solvent fluid of the stomach, it is not yet ascertained whether it is secreted by some of these little vessels, in their simple form, or in their more complicated glandular arrangement. It is common for writers on physiology, to speak of the *glands* which secrete the gastric juice, but the existence of these glands has never been demonstrated.

Follicles and Glands.

§ 333. The remaining functions belonging to, or immediately connected with the great enveloping and limiting membrane, appear to be performed by more complicated organs; and yet, when thoroughly analyzed, they are found to be scarcely less simple, than those described. The glandular follicles are the simplest kind of these organs. These are little bottle-shaped sacs imbedded in the substance of the membrane, with their mouths opening on its surface. The membrane continues into these mouths and lines the internal cavities of the sacs; or in other words, the sacs are formed by the membrane itself, and supplied with numerous nerves and blood-vessels, and appear to possess a contractile tissue, by which they are enabled, at any time, to expel their contents. These abound in every part of the membrane; but cluster more numerous in some parts than in others, as the wants of the organic economy demand. Though apparently similar in their anatomical structure, they differ very considerably in the character of their functions. Some of them secrete the mucus which everywhere lubricates the membrane, and imbeds and protects

its delicate nerves and vessels. (§ 287.) Others, situated on the external surface of the body, secrete the unctuous matter which oils the skin:—of these sebaceous follicles, there are said to be not less than a hundred and twenty millions:—others, situated in the exterior cavities of the ears, secrete the *cerumen* or wax of those cavities. Whether the coloring matter of the skin, is a distinct secretion, by a special set of organs, or, whether it is an effect of the action of light and heat and perhaps the oxygen of the atmosphere upon the mucous coat, is yet an unsettled point.

§ 334. The next form of a gland, is still more complicated, and much more extensive. Instead of the little sacs which I have just described, the membrane forms a tube like the barrel of a small quill, and this tube, like the main stem of a shrub, gives off many branches and each of these branches divides into a very great number of twigs, and these are all hollow and formed by the same continuous mucous membrane; so that, all the minute hollow twigs open into the hollow branches, and all the hollow branches open into the hollow stem, or main tube, and this opens upon the face of the great membrane. This ramified tube or duct is more or less extensive, according to the size of the gland, and the particular character of its function. But whether more or less extensive, it only differs from the little sacs, in shape and extensiveness.—To complete the structure and functional capacity of the gland, an artery advances to the main tube, and suddenly divides into a great number of branches, and each of its branches, into an immense number of twigs (fig. 24.) and these minute twigs terminate in the membrane which forms the hollow twigs and branches of the tube or duct: and where these arterial twigs terminate, an equal number of venous twigs

arise, which run together, and form branches, and these run together, and form the venous trunk, or trunks of the gland, corresponding in ramification, with the artery, but generally somewhat greater in capacity; and passing from the gland by the side of the artery. With these

Fig. 24.



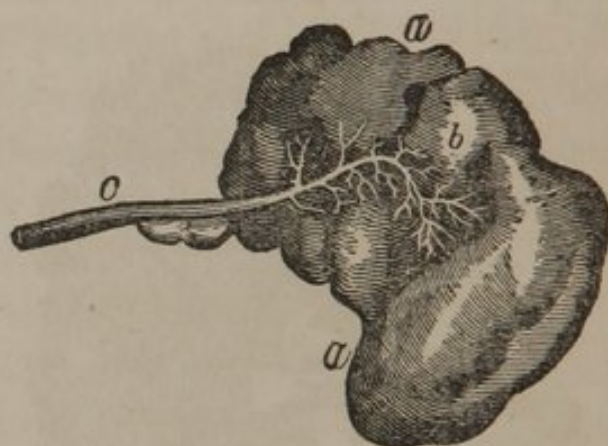
An artery of a gland dissected out.

vessels, which almost form a dense plexus, are also associated a great number of lymphatic vessels: and all these capillary arteries, veins and lymphatics are largely supplied with nerves of organic life (§ 231.) and intimately woven together into a single organ, by a delicate cellular tissue; and finally, the whole are enveloped in a serous membrane; and thus the gland is completed. (Fig. 25.) Some of the glands are provided with a membranous sac, which is also lined with the mucous membrane, and in which the secreted fluid or substance is deposited for a time.

§ 335. This is a general description of what are called the conglomerate glands, such as the salivary glands, the pancreas, the liver, &c. In one important respect, however, the structure of the liver, differs from

that of other glands. This peculiarity I shall notice when I come to speak of its particular function. (§ 381.) But as a general statement of this class of glands, the arteries pour their blood into their myriads of minute twigs, which terminate in the mucous membrane that forms the

Fig. 25.



A gland, *a a*, with its excretory duct, *c*, and branches, *b*.

hollow twigs and branches of the main tube or duct of the gland, and there the peculiar secretion of the gland takes place, in a manner of which we are totally ignorant. All we can say is that, it is an effect of vitality, which seems, in many instances, actually to possess the power of transmuting one substance into another: (§ 51.) for, many of the secretions are totally unlike any thing to be found in the blood, from which they are secreted. The blood thrown into these vessels, which is not employed in the secretion, becomes changed in its character by the process, and is taken up by the venous capillaries, and carried off into the general returning circulation. The office of the lymphatic vessels in these glands, is not fully ascertained, but it is supposed to be the absorption of such substances as ought not to pass into the secretion, nor to be carried off to the heart unchanged, in the venous blood. These substances may be, impurities brought into the gland in the blood, or

extravasated fluids, or the decomposed matter or the lymph of the gland; and, in some cases, the lymphatics are supposed to absorb the more aqueous parts of the secretion itself.—These glands are situated in different parts of the body, according to the wants of the vital economy. A considerable number of them however, appertain to the alimentary cavity, and constitute a portion of the alimentary apparatus. It may therefore, almost be said that, the great enveloping and limiting membrane, which covers the external surface of the body, and lines all the open cavities, is one extended and complicated organ of secretion and excretion,—of absorption and of depuration.

§ 336. The external skin I have said, is covered everywhere, by a thin membranous form of horny matter called the cuticle or epidermis; (§ 287.) and some anatomists say that, this epidermis extends over the whole mucous membrane. Dr. Horner of Philadelphia assures us that he has fully demonstrated its existence in the small intestine, and he therefore concludes that, it pervades the whole alimentary cavity.* How the substances which enter, or pass from the vital domain, get through the epidermis, where it does exist, is a question much disputed. Some physiologists say that, there are myriads of pores in the epidermis of the external skin, through which the perspired fluids, &c. pass; while others confidently deny the existence of a single one of these pores, and affirm that, whatever passes through the epidermis, does so by a kind of infiltration: and this, they think, is fully proved, by the fact that, when a blister is raised upon the skin, the serum which accumulates under the epidermis, does not escape, as it would, if there were numerous pores through which it could pass. But this seems to prove too much; for it equally proves the im-

* See Appendix, Note A.

perviousness of the cuticle by infiltration. Dr. Horner says he found it wholly impervious to the air, with which he inflated it, in a section of the intestine. The truth however, seems to me, to be most probably, this; when the cuticle, or epidermis is in its proper place, and holds its proper relation to the subjacent vessels and tissues, it presents openings to the mouths of those vessels, through which, they pour out, or drink in such substances as they give or take; but when it is raised up, and separated from its proper place and connexion, either by a serous fluid or by air, those openings, from the peculiar construction of the parts by which they are formed, become perfectly closed, and render the cuticle wholly impervious. The nerves of animal, and of organic sensibility, intimately associated with the minute vessels of the skin and mucous membrane, I have sufficiently described. (§ 290.)

§ 337. I have been thus minute and particular, in describing the great limiting membrane, which constitutes the confines of the vital domain, because it is the seat of many of the most important functions of the organic economy, and, as I have said, (§ 330.) is constructed with reference to all the relations, which the vital domain holds to the external world; and hence, it is impossible for any one to have a clear and full understanding of the laws of constitution and relation, under which man exists, without knowing the organization and physiological endowments of these important parts.

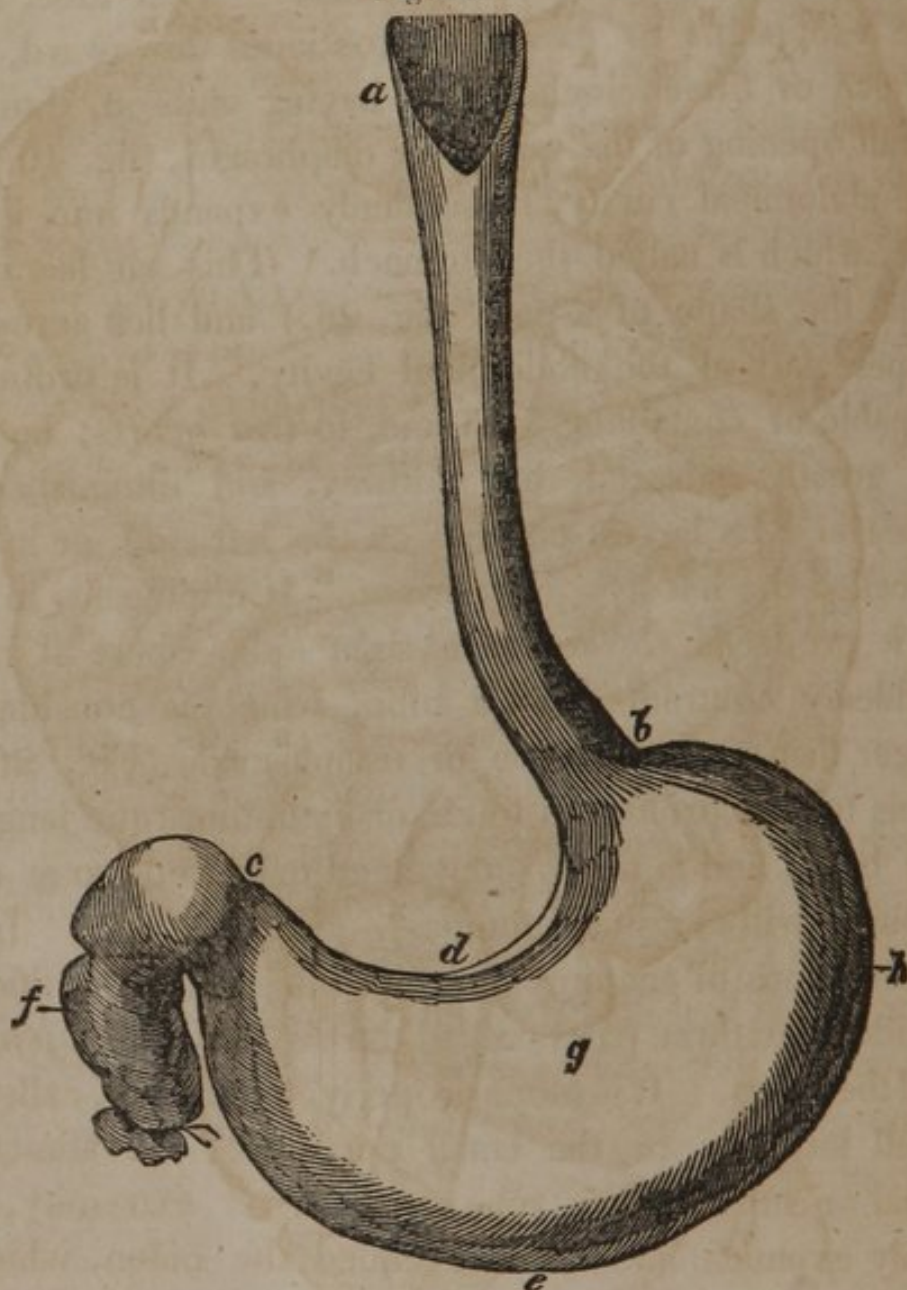
The Digestive Organs.

§ 338. The mucous membrane then, we perceive, is the grand seat of all the primary processes of alimentation; of the various functions of secretion and excretion, of respiration, &c. &c., and hence, it is so arranged as to constitute the most important portion of all the organs, by

which these functions are performed. Having lined the mouth and nasal cavities, it passes back, and unites in the fauces or throat, and thence descending, forms a funnel-shaped cavity, called the pharynx, which tapers downward, and gathers into a tube. This tube, called the œsophagus or meatpipe, continues downward, some twelve or fifteen inches, and having entered, through a small opening of the midriff or diaphragm, (fig. 40.) into the abdominal cavity, it suddenly expands into a large sac, which is called the stomach. This sac has somewhat the shape of a pear (fig. 26.) and lies across the upper part of the abdominal cavity. It is ordinarily, capable of containing from one, to two quarts; but may be greatly enlarged, by gluttony, and diminished by disease. Its largest end lies on the left side, or in what is called the left hypochondrium. It diminishes in size, as it proceeds towards the right side, where it rather suddenly contracts into a tube, which is considerably larger than the meatpipe or œsophagus. (Fig. 26. f.) This tube is prolonged to six or eight times the length of the body, and is nicely convolved or folded, so as to be brought within a small compass. (Fig. 27. S.) In the descriptions of anatomy and physiology, it is artificially divided into three parts, called the *duodenum*, the *jejunum* and the *ileum*. It is more properly, as a whole, called the small intestine, or the small portion of the alimentary canal or tube. This tube, at its lower extremity, suddenly expands into what is called the colon, which is much more capacious than the small intestine. (Fig. 27. U.) The colon ascends to the stomach on the right side—arches over the whole volume of the small intestine, and descends on the left side; forming in its lower part, what is called the *sigmoid flexure*: or, assuming the shape of an S; and then enters into the formation of a some-

what smaller tube, called the rectum, (fig. 27. V) at the lower extremity of which, the mucous membrane again blends with the outer skin.

Fig. 26.



a, the œsophagus or meatpipe; *b*, the cardiac orifice; *c*, the pyloric orifice; *d*, the small curvature of the stomach; *e*, the great curvature; *f*, the duodenum; *g*, the centre of the stomach; *h*, the splenic portion of the stomach. (§ 382.)

§ 339. Such is the general disposition of the mucous membrane, in forming the alimentary cavity. Throughout its whole extent, some of its little vessels (§ 331.)

exhale an aqueous vapor or serous fluid:—throughout its

Fig. 27.



A, the under side of the liver; *B, C, D, G*, the biliary ducts; *H*, the gall-bladder; *M*, the stomach; *P*, the pylorus; *R, S*, small intestine, terminating at *T* in the large intestine *U, W, X, Y*.

whole extent, its numerous little glandular follicles copi-

ously secrete, and pour out upon its surface, a lubricating and sheathing mucus, to keep its myriads of delicate little organs (§ 287.) in a proper state for the performance of their functions, and to protect them from the injurious action of whatever substances may be introduced into the cavity.

§ 340. In the oral cavity, on each side, near the

Fig. 28.



a, the salivary gland in the cheek; *b*, the duct leading to the mouth; *c*, the gland under the edge of the under jaw.

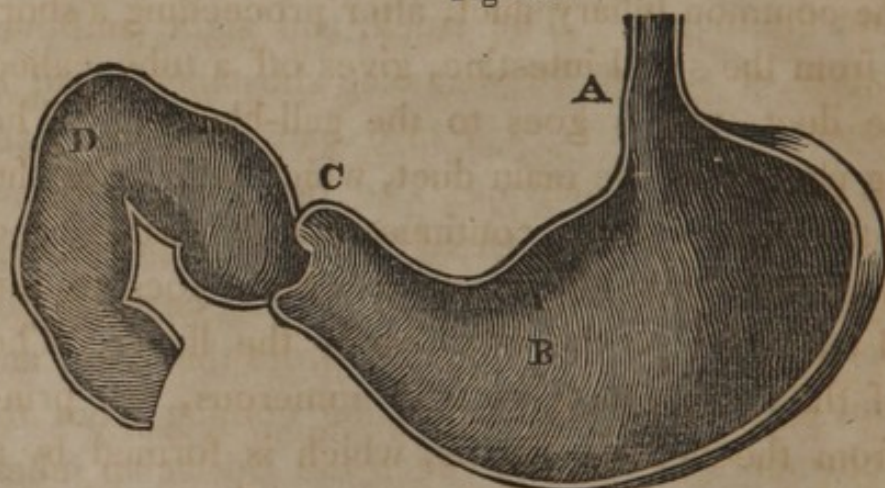
second double tooth in the upper jaw, the mucous membrane forms a little tube, (fig. 28. *b*) which ascends

along the cheek, and branches out and forms a gland in the manner I have described (§ 334.) in front of the lower part of the ear. (Fig. 28. *a*) Another smaller one of these glands, lies just within the lower edge of the under jaw, on each side, (*c*) and a third, and still smaller pair lie under the roots of the tongue, uniting on the middle line. The ducts of these last two pairs, open into the mouth in front of the roots of the tongue and near its bridle. These are all called the salivary glands. They secrete the saliva or the solvent fluid of the mouth, and pour it into the oral cavity freely during the process of mastication; and whenever any exciting substance is taking into the mouth. The smell, and sight, and even the thoughts of savory, or disgusting substances, and of other objects of desire, will also cause an increased secretion and flow of saliva. The oral cavity, I have said, (§ 338.) continues back, into the funnel-shaped cavity, called the pharynx. Into this last cavity, open also, from above, the canals coming from the nose, and near them, on each side, a little tube coming from the internal chambers of the ear, called the Eustacian tubes. These tubes are lined by the mucous membrane, and are so essential to hearing that if they become closed up deafness is caused. Just in front of these, is the soft pendulous body commonly called the palate;—but in the descriptions of anatomy, the vail of the palate. This, in the act of swallowing, is pressed back, and closes the nasal canals and the Eustacian tubes, so that, nothing can pass into them. A little lower down, near the roots of the tongue, in the front part of the pharynx, opens the *larynx*, or the mouth of the windpipe. This is so situated that every thing, which is swallowed, must pass directly over it. To prevent any of the food or drink from entering the windpipe, a small oval-shaped carti-

laminous valve is placed over the orifice. But as respiration requires that the mouth of the windpipe should only be momentarily closed, this little valve called the *epi-glottis* is always raised, except during the act of swallowing, when it shuts down over the orifice, and completely closes it, for an instant, while the food or other substances are passing, and then immediately opens.*

§ 341. Descending again, to the stomach, we find that, the œsophagus, or meatpipe does not enter this cavity at its end, or in the line of its longitudinal axis, but, as it were, at its upper side, (fig. 29. A) so that

Fig. 29.



A, the cardiac orifice of the stomach; *B*, the interior of the stomach; *C*, the pylorus; *D*, the interior of the duodenum.

the inferior mouth (*C*) of the stomach, which opens into the small intestine, (*D*) is little lower than that, at which the food enters (*A*) and which on account of its proximity to the heart is called the cardiac orifice. The inferior mouth of the stomach, (*C*) which lies in the right side of the abdominal cavity, is called the pyloric orifice. About four inches below this orifice, in the small intes-

* The fact that the glottis can close itself in the absence of the *epi-glottis* does not in the least degree prove that the *epi-glottis* is not designed to act exclusively as a valve to close the glottis in the act of deglutition.

tine, (D) is the mouth of another tube, formed, or lined by the mucous membrane. This tube ascends, and branches out, in the manner I have described, (§ 334.) and, together with appropriate vessels, nerves, &c. forms the largest gland in the body, called the liver. (Fig. 27. A A A.) This gland is situated at the top of the abdominal cavity, and lies immediately under the diaphragm; and mostly on the right side. It is divided into a large lobe and two small ones. On the lower surface of the large lobe, which lies on the right side, is formed a membranous reservoir, called the gall-bladder, which is also lined by the mucous membrane. (Fig. 27. B.) The common biliary duct, after proceeding a short distance from the small intestine, gives off a tube called the cistic duct, which goes to the gall-bladder. The remaining portion of the main duct, which now takes the name of the hepatic duct, continues a little farther, and then divides into two tubes, one of which, goes to the right and the other to the left lobe of the liver. The nerves of the liver, which are very numerous, are principally from the hepatic plexus, which is formed by a multitude of the branches of the nerves of organic life, and into which, some of the filaments of the pneumogastric, penetrate. (§ 245. 285.) By this plexus also, the liver is brought into very immediate and powerful anatomical, and sympathetic relations with the stomach. (§ 231.)

§ 342. The pancreas, which very closely resembles the salivary glands in its structure and in the character of its secretion, (fig. 30.) is situated behind the stomach, and lies crosswise of the body. (Fig. 31. P P.) It is about six inches long and one thick; and weighs from four to six ounces. Its duct generally enters the small intestine, at the same point, and in a common mouth with the biliary duct.

These excretory ducts and those of other glands, though formed essentially of the mucous membrane, as I have said, have also an exterior tunic of dense cellular substance.

Fig. 30.



The Pancreas.

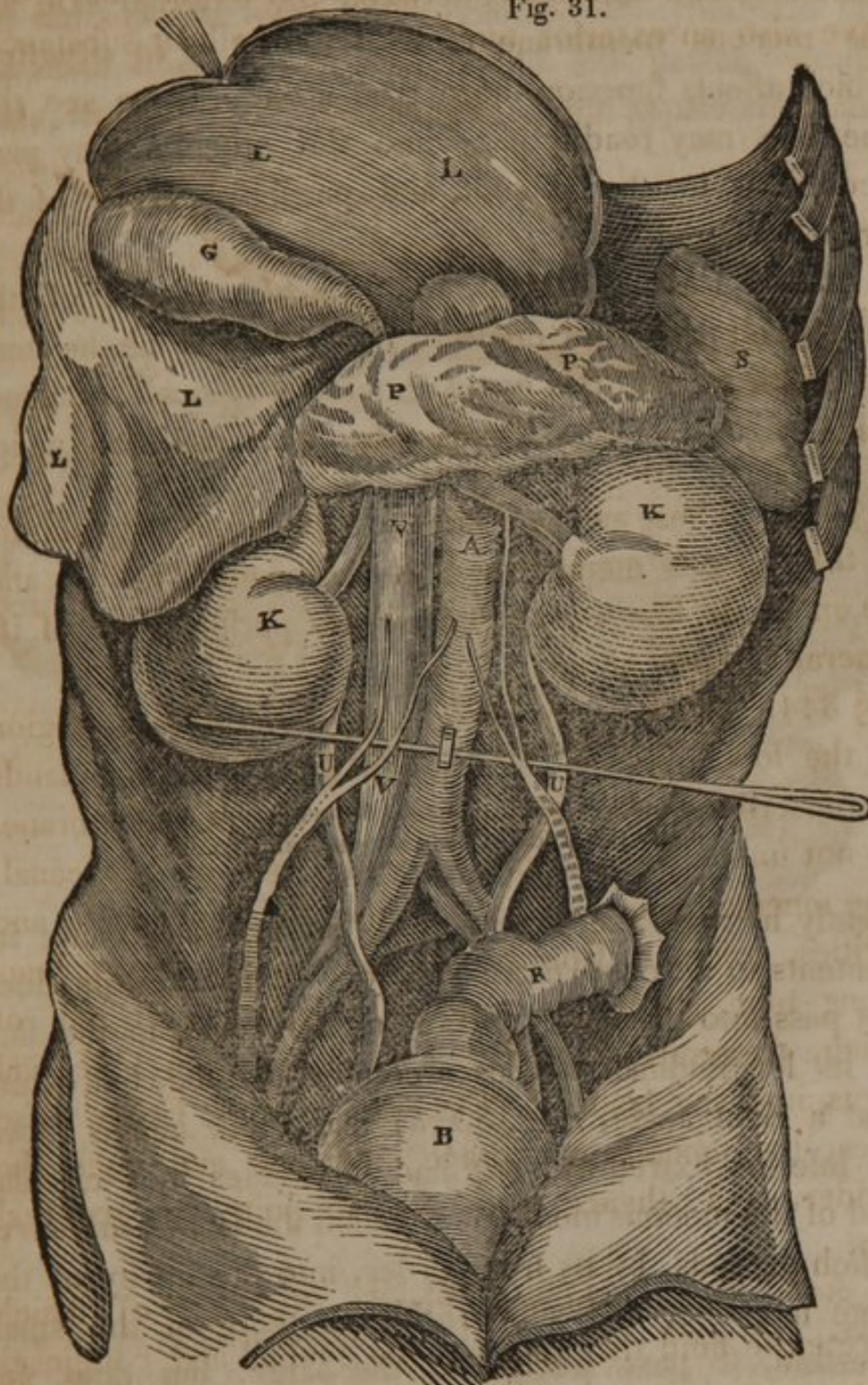
§ 343. These are the glands which immediately pertain to the mucous membrane of the alimentary cavity, and are more or less concerned in the performance of its general function of assimilation.

§ 344. The kidneys, which are situated in the region of the loins, (fig. 31.K) though they, like the glands just described, are founded upon the mucous membrane, are not immediately connected with the alimentary canal. The mucous membrane, which lines all their ducts and cavities, continues from each kidney, and forms, or lines a long tube, about the size of a writing quill, one of which, descends from the kidney, on each side, and opens into the bladder. (Fig. 31. U U.) From these tubes, the mucous membrane continues and lines the bladder, and thence proceeds to join the external skin.

§ 345. The lachrymal glands (fig. 52. a) which secrete the fluid that moistens the eyeball and composes the tears, and the other glands of the body, not particularly described, are all constructed upon the same general principles; having the mucous membrane for the grand foundation of their structure. But in all these glands,

this membrane is, as it were, isolated, and at a greater

Fig. 31.



A, the aorta; *B*, the bladder; *G*, the gall-bladder; *K*, the kidneys; *L*, the liver turned up, showing the under side; *P*, the pancreas; *R*, the rectum; *S*, the spleen; *U*, the ureters; *V*, the vena cava.

or less remove from the great sheets of the alimentary

and respiratory cavities. Yet, when it is remembered that, the main difference between the external skin and the mucous membrane (§ 287—289.) is *in situation*, which affects function more than structure, we see that the one may readily pass into the other, in any part, according to the general, and particular wants of the organic economy.

§ 346. Passing downward from the mouth of the biliary and pancreatic ducts (§ 341. 342.) along the small intestine, we find this organ abounding in small semilunar folds (fig. 32.) called the *valvulæ conniventes*, which

Fig. 32.

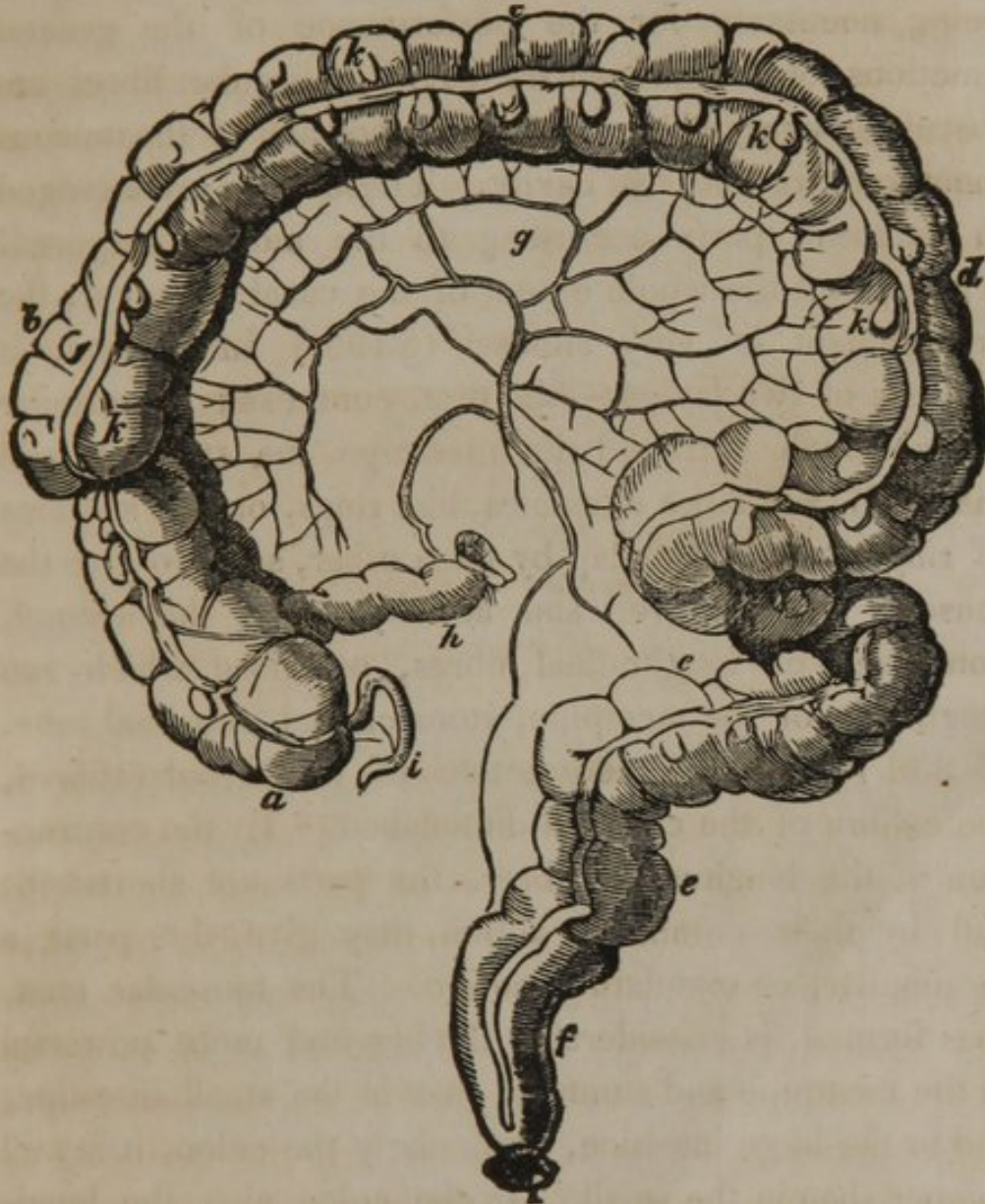


Section of the small intestine turned inside out to show the folds of its mucous membrane.

greatly increase the extent of its surface, and cause its contents to descend more slowly. This intestine does not pass into the large portion of the canal, in the line of its longitudinal axis, as a continuous tube, but enters it at a right angle, (fig. 33. *h*) about four inches above its inferior extremity; (*a*) and terminates in a circular fold of the mucous membrane, called the *ileo-cæcal valve*, which extends, by its free border, into the cavity of the large intestine, and suffers the contents of the small intestine, to pass freely into the large, but does not permit those of the large intestine to pass into the small. The portion of the large intestine, which extends below the ileo-cæcal valve, (fig. 33. *a*) is called the *cæcum*. It has the form of a sac opening into the colon; (fig. 35.

b c d) and is three or four inches in depth, and about the same in diameter. The colon is not cylindrical like the small intestine, but is gathered into partial circular folds, which give it a saculated form and appearance; and

Fig. 33.



a b c d e, the colon, showing its saculated form and general arrangement; *e*, the sigmoid flexure; *f*, the rectum; *h*, the small intestine terminating in the colon and forming the ileo-cæcal valve; *g*, the vessels crossing the mesocolon.

is secured in this condition, by three longitudinal bands. (Fig. 33.) In the rectum (fig. 33. *f*) this saculated form

disappears, and the canal again becomes more uniform and cylindrical.

Muscular Tissue of the Alimentary Canal.

§ 347. Motion, as well as innervation and secretion, being necessary for the performance of the general functions of the alimentary cavity, muscular fibres are therefore, everywhere attached to the back of the mucous membrane forming that cavity. These fibres are arranged in different parts according to the motion required. Throughout the whole extent of the canal however, the arrangement is very similar. (§ 199.) In general, it consists of two layers;—the first, composed of circular fibres, which surround the meatpipe, the stomach, and the small, and large intestines, like rings, or like sections of rings, whose ends lap by each other, so as to give the muscles more power and activity;—and the second, composed of longitudinal fibres, or those which run lengthwise of the meatpipe, stomach and intestinal tube. (§ 338.) By the contraction of the circular fibres, the calibre of the cavity is diminished. By the contraction of the longitudinal fibres, the parts are shortened; and by their combined action, they give the parts a vermicular, or undulating motion. The muscular coat, thus formed, is considerably thicker and more powerful in the meatpipe and stomach, than in the small intestine; and in the large intestine, particularly the colon, it is still thinner than in the small. In the colon also, the longitudinal fibres, instead of forming a continuous layer or sheet, as in the other parts, are gathered (§ 346.) into three separate longitudinal bands. (Fig. 33.) In the rectum again, the muscular coat becomes thicker and stronger and the longitudinal fibres form a continuous

layer around the tube. In the pharynx, (§ 338.) the arrangement is somewhat different:—here the muscular coat is composed of six constrictor muscles, the fibres of which, form sheets which cross each other in various directions. By the action of these muscles both the length and calibre of the pharynx are diminished. In the stomach, the fibres are disposed in three different directions,—longitudinally, circularly and obliquely. At the pyloric orifice of the stomach, the circular fibres gather into a thick and powerful band or ring, which, together with a thickening or folding of the mucous membrane upon itself, forms what is called the *valve of the pylorus*, (fig. 29. C) or more commonly, the pylorus or “gate keeper,” from which the orifice derives its name. When this ring is contracted, the orifice is closed, so that nothing can escape from the stomach downwards. Its office is to prevent the contents of the stomach from passing into the small intestine in a crude and undigested state.

§ 348. It is an interesting physiological fact, that the muscular coat of the alimentary organs, and particularly of the stomach and small intestines, is more or less developed, and powerful, and active, according to the character and condition of the food, on which the individual habitually subsists. Those kinds and conditions of food, which require considerable muscular action and power in the alimentary organs, conduce to the development, vigor and activity of the fibres which form their muscular coat, while the opposite kinds and conditions of food, conduce to the emaciation and feebleness and inactivity of those fibres, and in some instances the atrophy or wasting of the muscular coat of the stomach, proceeds to such a degree as to render its action exceedingly sluggish and feeble.

§ 349. Such is the general contractile tendency of the muscular coat of the alimentary canal, that when its several parts are not distended with food, their cavities are very considerably diminished; and by this means, the mucous membrane is gathered into numerous wrinkles or folds. In the meatpipe, these are nearly longitudinal. In the stomach the wrinkles run in every direction, and the

Fig. 34.



The folds in the mucous membrane of the stomach.

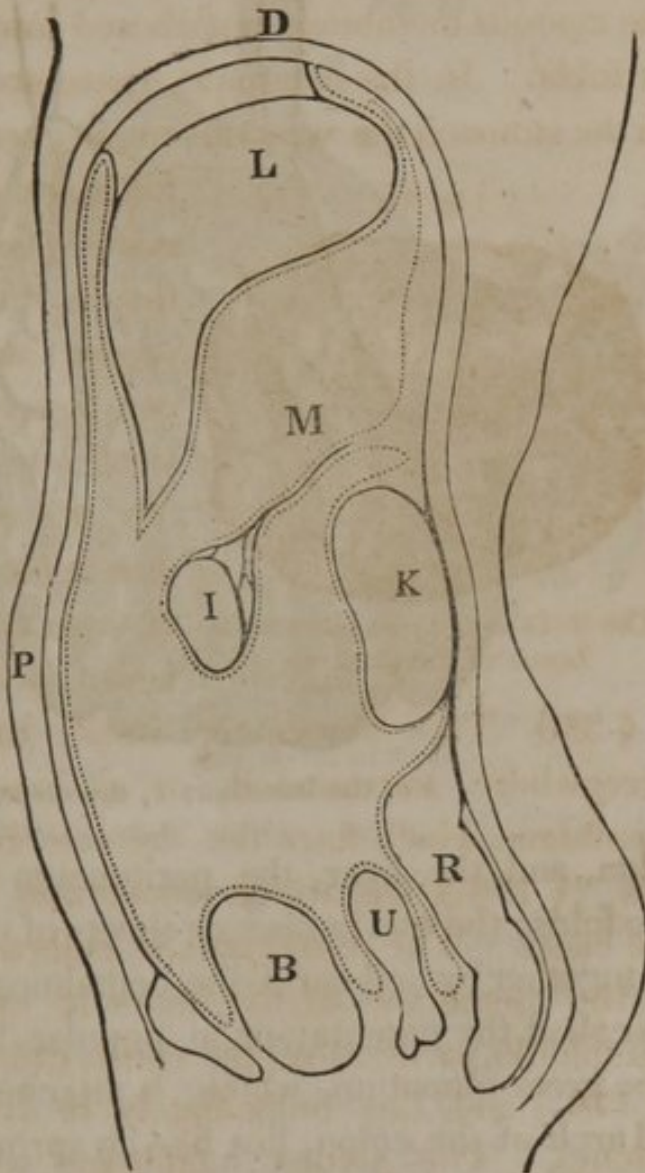
foldings are exceedingly numerous:—(fig. 34.) but in both of these organs they wholly disappear when the parts are completely distended. In the small intestine the folds (fig. 32.) are even more numerous than in the stomach, and many of them are also more permanent. (§ 346.)

§ 350. The alimentary canal, thus constructed, is everywhere, surrounded, or embraced by the serous membrane which lines the thoracic and abdominal cavities, (§ 176.) and which constitutes one of the coats of the canal. The œsophagus is embraced by that portion of the membrane of the thoracic cavity, which forms the middle partition of the chest, called the mediastinum, (§ 176.) and lies immediately in front of the spinal column. The serous membrane which surrounds the stomach, and the intestines, excepting the duodenum, is called their peritoneal coat. It serves in a measure, as I have said, (§ 176.) to isolate the organs—to present a smooth and lubricated surface, which enables the contiguous organs and parts to move upon each other without injury,—and, by its various attachments to the walls of the abdominal cavity and other parts, to keep each organ and portion of the alimentary canal in its

proper and relative position. (Fig. 35.) The portion of the membrane which thus secures the intestines, forms

Fig. 35.

The dotted line shows the arrangement of the serous membrane in the abdominal cavity; (§ 176.) lining *P*, the front wall of the abdomen, partially surrounding *B* *U* *R*, the organs of the pelvis, and *K*, the kidney; going down around *I*, the intestine, and returning and forming *M*, the mesentery; ascending to *D*, the arch of the diaphragm; and surrounding *L*, the liver, &c.



a gathered or folded curtain which extends from the back-bone (figs. 5 and 35. *M*) to the convolutions and arches of the canal, and thus, while it holds every part in its relative position, admits of a free floating motion of the whole. The curtain which belongs to the small intestine is called the mesentery, (fig. 36. *c*) and that which belongs to the colon, the mesocolon. On these curtains also, are ramified and distributed in great abundance,

the vessels and nerves that go to, and from the alimentary canal. (Fig. 33. *g*.) From the stomach, the arch of the

Fig. 36.



b b, the intestine; *c*, the mesentery.

colon, and the liver, the peritoneum depends, in extensive folds; the two laminæ or sheets of which, are connected together by cellular tissue containing fat. These folds are called the omenta; or in popular language, the caul. The great omentum, which is attached to the stomach, and arch of the colon, lies like an apron, free and floating upon the front of the convolutions of the small intestines. (Fig. 37. *g g*) The omenta are constantly moistened with a serous fluid which facilitates the movements of contiguous organs upon each other: they also receive the superfluous depositions of fat. The three coats of the canal, consisting of the mucous membrane, the muscular coat, and the peritoneal coat, or the serous membrane, are closely knit together, by a delicate cellular tissue.

The nerves distributed to the alimentary canal, and which preside over its functions, we have seen (§ 220.) are from the ganglionic system of organic life. These are exceedingly abundant in every part of the canal, imparting the stimulus of involuntary motion to its muscular tissue, (§ 219.) giving the functional power of absorption, secretion, excretion, exhalation, &c. to its myriads of minute vessels; (§ 230.) and organic sensibility, common and special, (§ 296.) to its whole extent of mucous membrane.—

(§ 290.) The stomach we have seen, (§ 231.) is very largely supplied, not only from the great centre of organic life, but also from the centre of animal life, (§ 245.) and is thereby brought into the most immediate, powerful, and important relations and sympathies with each and every part of the system. (§ 297. 298.) The alimentary canal, however, being a general organ of external, as well as internal relation, designed to receive foreign substances, for the nourishment of the body, and to expel the unappropriated portions, its superior and inferior extremities are accordingly furnished with nerves and muscles which bring them under the cognizance and control of the animal centre of perception and of voluntary action. (§ 233. 302.) The mucous membrane of the mouth, nostrils, throat, pharynx and larynx or top



a b c, the stomach; *g g*, the great omentum, or caul.

of the windpipe is highly endowed with animal sensibility of touch, or feeling:—(§ 294.) that of the mouth, and particularly of the tongue, has also the sense of taste, and that of the nose, the sense of smell. The control of the WILL, or the voluntary action is nearly commensurate, in these parts, with the sense of feeling; and is exercised in chewing, swallowing, speaking, singing, &c. The nerves from which these parts derive their animal sensibilities and power of voluntary action, I have fully described. (§ 245—256.)

Respiratory and Vocal Organs.

§ 351. The respiratory organs are closely associated with the alimentary. Indeed, they constitute a part of the great assimilating apparatus of the system; for in them is completed the process of assimilation, which commences in the mouth or stomach; and, like the alimentary canal, the lungs are organs of external, as well as internal relation, and consist, fundamentally, of the mucous membrane.

§ 352. In the function of respiration or breathing, the trachea or windpipe, lungs, diaphragm, ribs and breast-bone, with numerous pairs of muscles, which move these bones, are the principal organs employed.

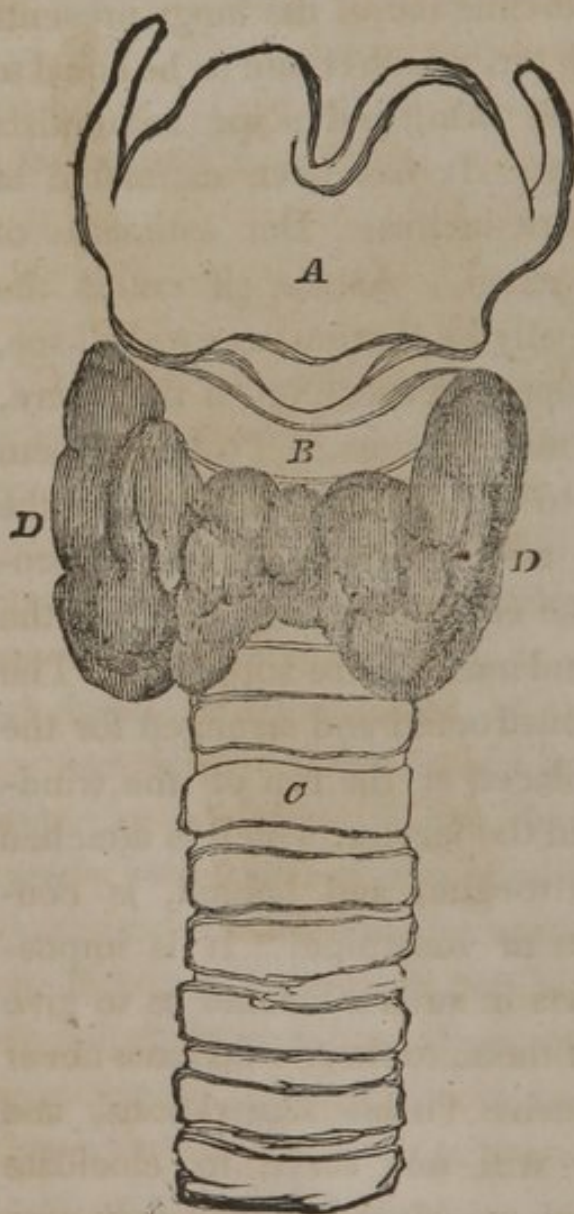
§ 353. I have said (§ 340.) that, the windpipe opens into the pharynx on the front side, just below the roots of the tongue. Here the mucous membrane continues down from the pharynx, and forms a tube about the size of the meatpipe when that organ is fully distended, or less than an inch in diameter. This tube descends several inches in front of the meatpipe, to the cavity of the chest, where it divides into two branches, the one going to the right, and the other, to the left side of the thoracic cavity. Here, each of the branches divides and subdivides, in

every direction, like an artery of a gland, (fig. 24.) till they form a thick brush or broom, of minute hollow twigs; and each of these twigs terminates in a little cell. These little air-cells are supposed to be about the one thousandth part of an inch in diameter, and their number, in both lungs, is estimated at more than one hundred millions. By this arrangement the mucous membrane of the lungs presents an extent of surface to the air, which is said to be equal to that of the whole external skin; and some anatomists say that it is much greater. It has been estimated at twenty-one thousand square inches. But estimates of this kind, cannot be very exact. As the air enters the windpipe and lungs principally by suction, as we shall see, these tubes would all collapse, or close up, if they were, like the meatpipe, purely membranous. To keep them distended therefore, and to enable the individual by the voluntary control of the respiratory apparatus, to produce sound or voice, in the emission of the air from the lungs, various cartilages and muscles are supplied. The parts more particularly constructed and arranged for the production of voice, are placed at the top of the windpipe, and collectively called the larynx, which is attached above, to the bone of the tongue, and behind, is connected with the œsophagus or meatpipe. It is impossible to describe these parts in such a manner as to give a clear and accurate idea of them, to those who have never seen them, without extensive visible illustrations, and as their minute anatomy will not serve to elucidate any important physiological principle, I shall only give a general description of them.

§ 354. The larynx is composed of five cartilages, which are moveable one upon another by the action of several muscles. 1. The *thyroid*, or shield-like cartilage, (figs. 38. 39. A) which is the largest of the five and forms the upper, and

anterior part; and produces at the upper part of the neck, the prominence called *Adam's apple*. 2. The *cricoid* or ring-like cartilage (B) which is placed below the thyroid, and like that, can readily be felt in the fore part of the neck. It is narrow in front, and thick, broad, and

Fig. 38.



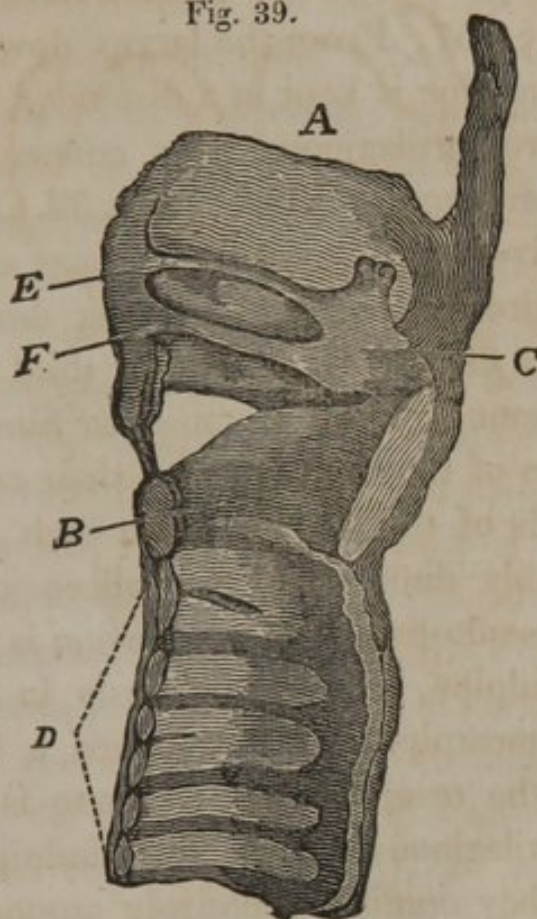
strong behind. Its upper edge has its front part fixed to the thyroid cartilage: its lower edge is connected to the whole circumference of the commencement of the trachea. 3. and 4. The two *arytenoid*, or small pyramid-shaped cartilages (fig. 39. C) which are situated at the upper and back part of the larynx, above the cricoid cartilage, to which they are attached by a strong ligament, (fig. 39. E) and upon which they have a sliding motion in every direction; 5. The *epiglottis*, a soft, fibro-cartilage of an ovoid form, situated at the upper part of the larynx, under the

roots of the tongue and placed obliquely over the glottis or mouth of the windpipe, which opens into the pharynx, forming a valve by which the glottis is closed in the act of deglutition. (§ 340.) “On the inside of the

larynx, there are two ligaments, formed of elastic and parallel fibres, and extending forward from the anterior part of each arytenoid cartilage, to the thyroid cartilage where they meet. These are called the *chordæ vocales* or the vocal ligaments. (Fig. 39. F.) The opening between them, is the entrance into the windpipe, and is called the glottis.

This narrow chink is capable of being enlarged, contracted or wholly closed. Immediately above these two ligaments are two small pouches, termed the ventricles of the larynx; and above the ventricles, are situated two other ligaments formed of mucous membrane, and extending between the arytenoid and thyroid cartilages, above the *chordæ vocales*; so that, the ventricles of the larynx are situated between these ligaments and the vocal chords.

Fig. 39.



§ 355. "All the modifications of the voice, are produced by the air, passing out of the lungs through the larynx. The sound is occasioned by the vibration of the vocal ligaments. According to Magendie the gravity or acuteness of the sound, depends on the greater or less approximation of the arytenoid cartilages toward each other. But Mayo remarks that the pitch of the voice has no reference to the size of the aperture between the vocal chords, nor to any alteration of their length, but

depends solely on their *tension*, and, consequently, on the frequency of their vibrations."*

§ 356. The whole larynx may be elevated towards the chin, or depressed towards the sternum, by the action of appropriate muscles, situated in the parts. It is supplied by four nerves, all of which are furnished by the pneumogastric which I have described. (§ 245.)†

§ 357. From the larynx downward into the lungs, the windpipe is kept in a distended form, by a succession of fibro-cartilaginous rings connected with each other by a membranous texture. (Fig. 38. C. 39. D.) For important purposes however, these rings as they are called, are not entire circles; but each ring describes about two thirds of a circle, and the other third is occupied by a membranous texture of muscular fibres running in the direction of the rings: so that, their contraction draws the two ends of the ring nearer to each other, and thus, considerably diminishes the calibre of the windpipe. This musculo-membranous portion is in the back part of the windpipe, and contiguously in front of the œsophagus or meatpipe:—so that, when a bolus of food descends, in the œsophagus, its course is not obstructed by the cartilaginous rings of the windpipe, as would be the case, if they continued entirely around. But if the bolus is too large, it presses in the membranous portion of the windpipe, to such an extent, as to cause the distressing sensation of choking; and in some cases, so nearly closes the windpipe, as to cause suffocation and death.

* Oliver's First Lines of Physiology p. 453.

† In front, and somewhat below the larynx is situated a soft, spongy body called the thyroid gland, the use of which is not known. It consists of two lobes, one on each side, which are united in the middle. (Fig. 38. D.) It receives blood from four arteries, but has no excretory duct. It is usually larger in females than in males, and larger in early life than in more advanced age.

§ 358. As the branches of the windpipe become more and more subdivided, in the substance of the lungs, the rings become less and less cartilaginous, and gradually soften down, and fade away, and finally, disappear entirely; leaving nothing, but the membranous form of the small air-tubes. It is however, asserted by some anatomists, that the transverse muscular fibres, by the contraction of which the calibre of these tubes is diminished, are continued down to the smallest subdivisions and that they are employed in the act of expiration, in expelling the air from the lungs; and that it is to this contractile tissue, that the pulmonary branches of the pneumogastric nerve are mainly distributed. (§ 245.)

§ 359. A large pulmonary artery, rising from the heart, (fig. 43. *k*) divides like the windpipe (§ 353.) into two branches, one of which, goes to the right branch of the windpipe, and the other, to the left. These now ramify in the same manner as the windpipe, (fig. 24.) so that, their branches and twigs correspond with those of the windpipe; and finally, the extremely minute twigs of the artery terminate in the sides of the air-cells at the extremities of the minute air-tubes. (§ 353.) Where the arterial capillaries terminate, the venous capillaries rise; and, running into each other, the vessels become larger and form branches corresponding with those of the artery, till they swell into large pulmonary veins which emerge from the lungs by the side of the arteries, and proceed to the heart. (Fig. 43. *m m*.)

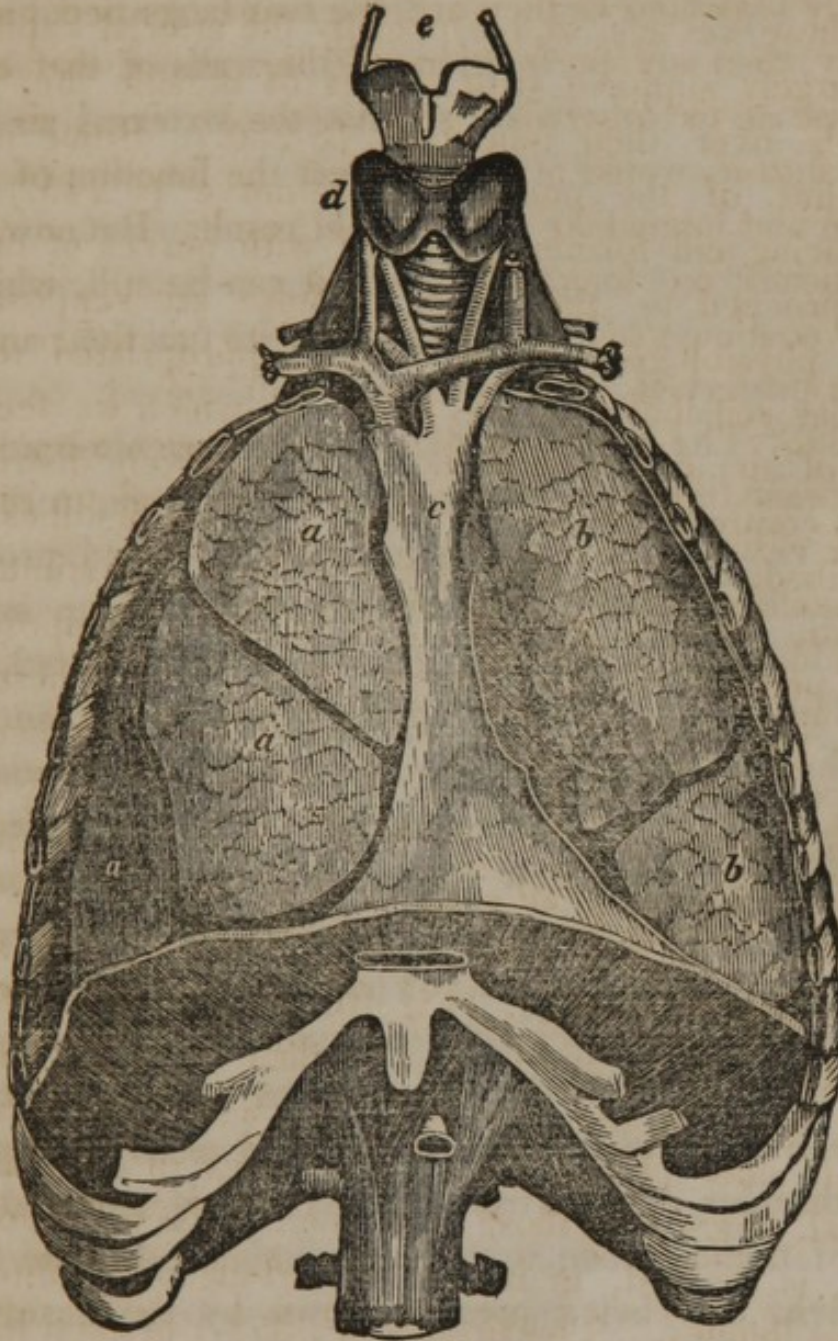
§ 360. These pulmonary arteries convey the blood from the heart to the lungs, where it undergoes important changes, and then, the veins carry it back, from the lungs to the heart. The lungs however, are not in the least degree nourished by this circulation. The bronchial arteries, which nourish all the tissues of the lungs,

and the veins which correspond with these arteries, are ramified like those just described, and extend to every portion of the pulmonary structure. Besides these, lymphatic vessels are numerous distributed in every part. All these vessels, and especially the arterial capillaries are largely supplied with nerves of organic life, which preside over their functions. (§ 230.) Some of the branches of the pneumogastric nerve (§ 245.) after interlacing and forming plexuses with nerves of organic life, proceed to the lungs. These are supposed by some physiologists, to be wholly appropriated to that peculiar sensibility of the lungs, by which we feel the want of air; others think they are exclusively distributed to the contractile tissue or muscles of the air-tubes, just described, (§ 358.) and convey to them the stimulus of motion. Others, perhaps more correctly, suppose that they perform both of these offices.—All these air-tubes, vessels and nerves are closely knit together into one general texture, by a delicate cellular tissue, (§ 171.) and the whole mass, on each side, is enveloped in the serous membrane as an external coat. (§ 176.)

§ 361. The right lung is larger than the left, and is divided into three lobes. (Fig 40. *a a a*.) The left, has two lobes; (*b b*) and is smaller than the right lung, to make room for the heart, (§ 175.) which lies partly on the left side. (Fig 4. *H*.) The lungs of men are, in general, larger than those of women. Each lobe of the lungs, is divided, in its internal arrangement, into numerous lobules. The air-cells (§ 353.) of each lobule, communicate with each other, but the cells of one lobule have no direct communication with those of another. The two lungs are completely separated from each other, and from all the other organs, by the serous membrane, here called the pleura, (§ 176.) which lines the thoracic

cavity, and divides it into two chambers, by passing double, across it, from the breast-bone to the back-bone, (fig 40. *c*) and thus forming a closed sac for each lung,

Fig. 40.



a a, the right lung; *b b*, the left lung; *c*, the mediastinum;
d e, the top of the windpipe.

and embracing the heart, the large blood-vessels and the meatpipe (§ 350.) between the two sheets of the mediastinum, or middle partition.

§ 362. By this arrangement, every part is kept in its proper place and condition; and an admirable provision is made against evils which might otherwise, arise from injuries of the chest and lungs. If instead of being completely separated as they are, the two lungs occupied one cavity, then any perforation of the walls of that cavity, by disease or otherwise, so that the external air could rush into it, would at once arrest the function of respiration and immediate death would result. But now, if by any means, one lung is disabled, it can lie still, while the other continues faithfully to perform its function; and thus life is preserved.

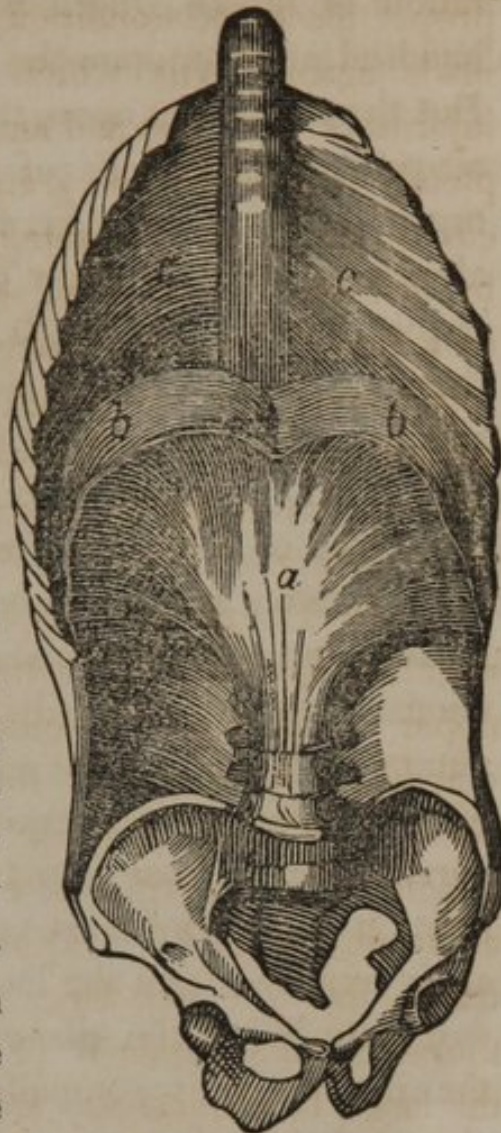
§ 363. The diaphragm (§ 175.) is a musculo-tendonous membrane, which is attached, by its two legs, to the two upper vertebræ of the loins, (fig. 41. *a*) and proceeds diagonally upwards and forwards,—arching up into the chest like a bridge or dome, (figs. 4. and 35. *D*) and, being attached, by its peripheral edge, to the walls of the body, all around, (fig. 41. *b b*) so as completely to divide the trunk, into the two large cavities (§ 175.) called the thoracic and abdominal. (Fig. 41. *c a*.) The meatpipe, the large blood-vessels, &c. pass through this partition near the spinal column. The legs and centre of the diaphragm, are principally tendonous, and its wings are muscular. By the contraction of the muscular portions, the arch of the diaphragm is reduced nearly to a plane; and thereby, the cavity of the chest is enlarged, and that of the abdomen, somewhat diminished,—the liver, stomach, &c. being pressed down by the descending diaphragm. (Fig. 4.)

§ 364. In describing the bones of the body, I said (§ 181.) that, the ribs (fig. 8. *c c c*) are fastened by cartilages and ligaments, to the spinal column, (*b b*) and most of them, by a double attachment; and that, they

droop, as they proceed forward, to be connected with the sternum or breast-bone: (*a*) so that, the front ends of the ribs, when in their most natural, or resting position, are considerably lower than the back ends. (Fig. 8.) By this arrangement, when the various muscles concerned in elevating the breast-bone and the ribs, are contracted, the breast-bone and the front ends of the ribs, are raised up so as to bring the ribs nearly to a horizontal position: and this also, considerably enlarges the cavity of the chest. When therefore, the diaphragm is drawn down, and the breast-bone and ribs are elevated, the cavity of the chest is much enlarged.

§ 365. It is a matter of general knowledge that, the atmosphere has weight, or that like other ponderable substances, it gravitates towards the centre of the earth; and that, it presses on the surface of the earth and things on the earth, at, or near the water's level, at the rate of about fifteen pounds to every square inch of surface. This pressure being the same on every part of our bodies, we do not feel it. But if the air could be entirely expelled from the lungs, and the mouth and nose completely

Fig. 41.



The diaphragm during expiration; *a*, its tendonous centre; *b b*, its fleshy sides; *c c*, the lateral cavities of the chest in which the lungs lie.

closed, and the thoracic cavity enlarged, as in a full inspiration of breath, there would be a pressure of many hundred pounds, upon the external surface of the chest. But the nose being open, the air rushes into the windpipe, air-passages, and cells of the lungs and distends these organs; so that, they at all times just fill the cavities allotted to them, and no vacuum is produced, and consequently, no pressure is felt. In ordinary breathing, therefore, the muscles which elevate the breast-bone and ribs, slightly contract, and the arch of the diaphragm, (fig. 35. D) is simultaneously drawn down, and thereby the cavity of the chest is enlarged, and at the same time, the air rushes in and inflates the lungs; and then all the muscles employed in producing these motions, instantaneously relax, and the ribs and diaphragm return to their natural position, by the elasticity of the cellular tissue, (§ 169.) the force of gravity and the pressure of other parts. By these means, and perhaps, also, by the contraction of the muscles of the air-tubes, (§ 358.) the air is expelled from the lungs.

§ 366. When the ribs are confined by tight clothing, the diaphragm is compelled to carry on the function alone; but in this case respiration is much restrained. In violent and rapid breathing, the abdominal muscles probably assist, in the act of expiration. We see then that, it is not by a direct action of the WILL upon the lungs, but upon the diaphragm, and the muscles which elevate the breast-bone and ribs, and upon the parts which compose the larynx, or organs of voice, that we have, to some extent, a voluntary control over the acts of inspiration and expiration; and this, we have seen, (§ 302.) is necessary in order to the protection of the lungs from offensive air, &c. and to the production of voice, speech, &c.;—but when neither of these final

causes, demands the immediate exercise of the WILL, the function of respiration is wholly given up to organic instinct, and is carried on without our care, and in health generally without our consciousness. All the muscles of animal life therefore, concerned in the general function of respiration, are associated in the regular performance of this function, with those of organic life or of involuntary motion.

Organs of Circulation.

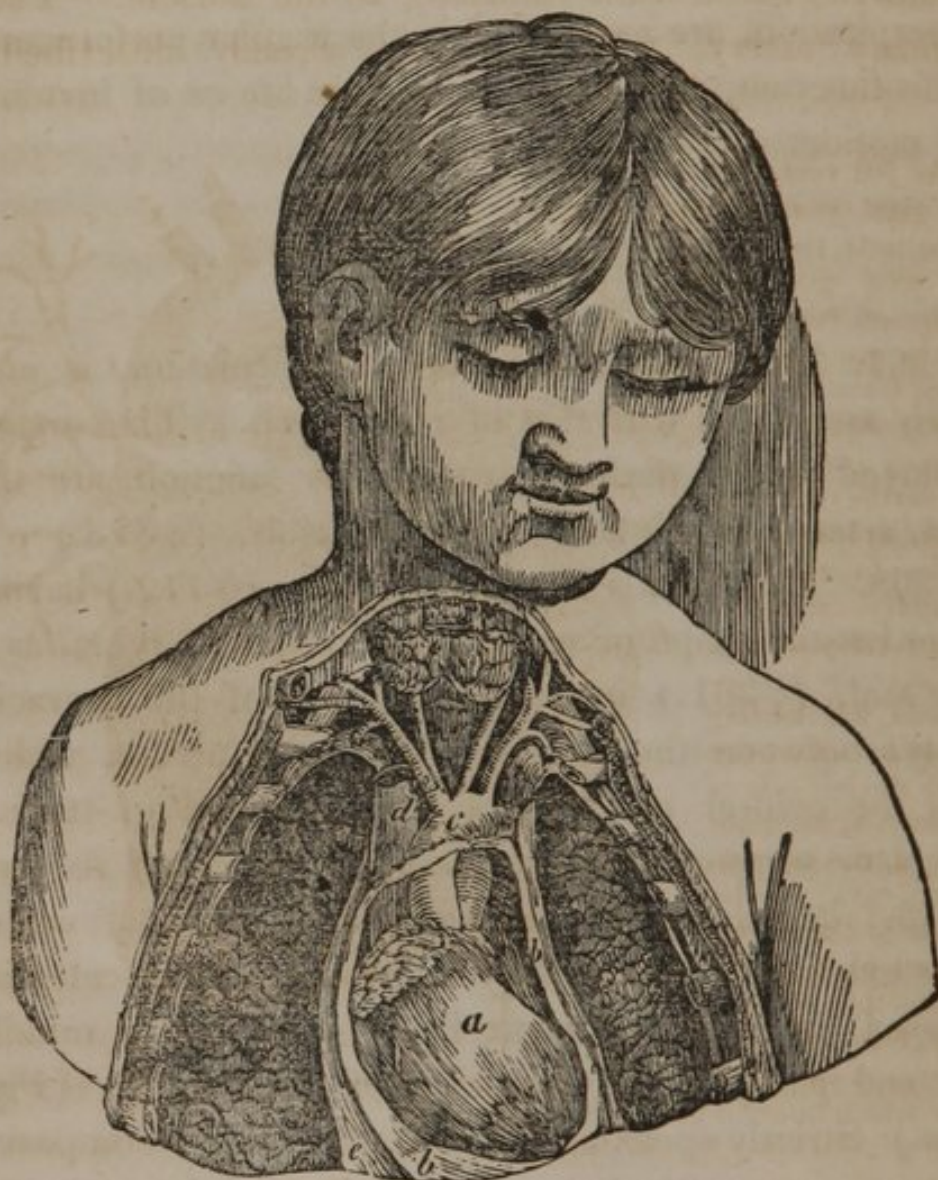
§ 367. The general function of circulation, is intimately associated with that of respiration. The organs employed in the performance of this function, are the heart, arteries, veins and capillary vessels. (§ 313.)

§ 368. The heart is a muscular organ (§ 172.) having somewhat the shape of an inverted cone; and lying, as I have said, (§ 361.) in the lower part of the thoracic cavity, between the two sheets of the pleura, which form the central partition of the chest. (Fig. 40. c.) It is also, surrounded by a membranous sac of its own (§ 176.) called the pericardium (fig. 42. b b.) which by its exhalations, continually moistens and lubricates its enclosed organ. The heart lies partly on the middle line, and partly in the left side of the chest. (Fig. 42. a.) Strictly speaking, it is a double organ; composed of two corresponding halves,—each half having an upper and a lower chamber, or cavity. The upper chambers are called auricles, and the lower ones, ventricles. (Fig. 43. a b n.)

§ 369. Before birth, there is an opening between the auricles, through which, a portion of the blood passes from the right auricle to the left; but after respiration commences, there is no direct communication between

the two halves of the heart. The auricle on each side, however, communicates freely, with its corresponding ventricle. The cavities of the right side of the heart

Fig. 42.



The cavity of the chest laid open, to show the heart and lungs. *a*, the heart; *b b*, the pericardium, cut open; *c*, the aorta, the great artery of the left side, that distributes the blood to all parts of the body; *d*, the great vein, called the descending vena cava, which, with the ascending, brings the blood to the right auricle; *e*, the pleura or membrane that covers the lungs.

are somewhat more in front, than those of the left. The right auricle receives the dark blood that returns in the veins from all parts of the body, and, contracting

upon it, sends it into the right ventricle, through an orifice, which is furnished with membranous folds, so arranged as to form a *triplex* valve, called the *tricuspid valve*; which, being pressed back, closes the orifice, and prevents the blood from returning to the auricle. The pulmonary artery, which I have already described,

Fig 43.

a, the left ventricle;
b, the right ventricle;
c e f, the aorta, the great artery that goes off from the left ventricle;
g h i, the arteries that are sent from the arch of the aorta;
k, the pulmonary artery, that goes from the right ventricle to the lungs;
l l, branches of the pulmonary artery, going to the two sides of the lungs;
m m, the pulmonary veins, which bring the blood back from the lungs to the left side of the heart;
n, the right auricle;
o, the ascending vena cava;
q, the descending: these two meet, and by their union, form the right auricle;
p, the veins from the liver, spleen and bowels;
s, the left coronary artery, one of the arteries which nourish the heart.



(§ 359.) rises from the right ventricle, (fig. 43. *k*) and soon divides into two branches, called the right, and left pulmonary arteries, which are ramified (fig. 43. *l l*) with the branches of the windpipe, in the formation of the lungs. The orifice of the pulmonary artery is furnished, internally, with three membranous folds, called the *semi-lunar valves*. These suffer the blood to pass freely, from the heart into the artery, but prevent its re-

turning from the artery to the heart. Through this artery the right ventricle sends its dark blood to the lungs, where it is changed into bright red, arterial blood, which is conveyed to the left side of the heart, by the pulmonary veins which I have also, described. (§ 359.) These veins, advancing from the lungs in two trunks on each side, open into the left auricle. (Fig. 43. *m m.*) From this auricle, the blood passes into the left ventricle, through an orifice like that on the right side, which is furnished with a fold of membrane, called the *mitral valve*, which prevents the blood from returning to the auricle. From the left ventricle, opens the mouth of the great arterial trunk called the *aorta*, through which passes all the blood that nourishes the body. This orifice is furnished with three semi-lunar valves, similar to those, at the entrance of the pulmonary artery; and which, like them, suffer the blood to pass from the ventricle into the artery, but prevent its returning from the artery to the ventricle.

§ 370. It is probable that, at first, the heart consists only of the left ventricle, (§ 219.) and that, the other parts are added, as the general development of the system, progresses. It is not however, until respiration, and with it the pulmonary circulation commences, that all the cavities of the heart, come into the regular performance of their appropriate functions.

§ 371. The muscular power required in the auricles, being much less than in the ventricles, the walls of the former are much thinner than those of the latter. The right auricle is somewhat larger than the left. The cavities of the ventricles are nearly of a size, but the walls of the left, are much thicker and more powerful than those of the right.

§ 372. In the actions of the heart, the two auricles

contract simultaneously, and the two ventricles contract simultaneously: but the auricles and ventricles contract alternately, so that, as the two auricles contract, the two ventricles dilate, and as the two ventricles contract, the two auricles dilate.

§ 373. The muscles of the heart, are supposed by some physiologists, to possess a peculiar irritability, (§ 231.) which causes them to contract from the stimulus of the blood in the cavities, but it is more probable that, the heart has cognizance of the blood in its cavities, by means of its nerves of organic sensibility. (§ 230.) Some also, suppose that a positive distending muscular force is employed in the dilatation of the cavities. But this appears to be both impracticable and unnecessary. The elasticity of the cellular tissue, is probably sufficient for that effect. (§ 158. 312.)

§ 373. The nerves of organic life, I have said, (§ 219.) preside over all the functions of the sanguiferous system. The heart, which in its rudimental state, is closely connected with the central brain of that system, (§ 219. 231.) is gradually removed, as the several parts are developed, till it becomes established in the thoracic cavity:—and the ganglionic masses, from which its nerves principally issue, are situated in the neck and upper part of the chest. (Fig. 14. *x*.) Some of the branches of the pneumogastric, it will be recollected, (§ 247.) enter also, into the cardiac plexuses, but few, if any of them, reach the heart. At any rate, they neither bring it, in any degree, under the control of the WILL nor render it cognizable to the centre of animal perception. (§ 302.) The heart, therefore, is entirely independent of the WILL; yet its action is more or less accelerated or retarded by every emotion of the mind. This however, principally depends on its organic sympathy with the

stomach, and with the great centre of organic life, and through them, with the brain. (§ 303.) For the heart is in no degree, the seat of those emotions or feelings which are, in common language, referred to it.

§ 374. From the left ventricle of the heart, as we have seen, (§ 369.) rises the great arterial trunk, called the *aorta*, or *air-keeper*:—(so named by the ancients because they supposed all the arteries were air-tubes;—they being generally found empty after death.) This trunk ascends a short distance, towards the head, and then forms an arch (fig. 43. *c e f*) and descends, behind the heart, and in front of the spinal column; passing through the diaphragm, and dividing in the lower part of the abdominal cavity, to proceed to the two lower limbs. (Fig. 31. A.) Almost immediately, after leaving the heart, it gives off two branches which go to nourish that organ;—for neither the heart, nor any of the blood-vessels receives nourishment directly from the blood which flows in it; but they are all, even to the smallest vessels, nourished by arteries distributed to their tissues for the special purpose. At the top of its arch, the aorta gives off three large branches (fig. 43. *g h i*) which are divided into the internal, and external arteries of the head,—arteries of the face and neck,—arteries of the arms, &c. As the aorta descends, it gives off branches, all along its course, which go to the internal organs, to the walls of the body, &c. All these different branches, as they proceed towards their destination, divide, and subdivide, and inosculate or run into each other, in every direction, like a net, (fig. 33. *g*) till they become extremely minute twigs, which are lost in the tissues of the parts to which they are distributed,—penetrating to the smallest muscular, and nervous filaments, and being dispersed so universally, and so numerous, over the whole body, that it is

scarcely possible to puncture any part, with a fine needle, without wounding some of these little vessels. These are called capillary or hair-sized vessels, and collectively with those of the veins, constitute the capillary system, (§ 313.) in, and by which, all the important changes in the blood are effected.

§ 375. The number, of these capillary vessels, has been estimated at more than one thousand to every square inch. Some physiologists have conjectured that, there is another set of almost infinitely minute vessels, connected with the capillary extremities, and immediately concerned in nourishing the several tissues, &c. which they call the exhalants: but this is mere conjecture.

§ 376. It is a general law, of the animal organic economy, that, all vital action is attended with an expenditure of vital power, and a waste of organized substance; (§ 192.) and these are replenished, by the arterial blood. In the distribution of arterial vessels, to the different parts therefore, each organ is supplied according to the nature of its function, and its relative importance in the system: and such is the general, and particular arrangement, that every part, and especially every important part is so furnished, that, if its blood be obstructed in some of its vessels, it freely flows on in others.

§ 377. The arterial vessels of the brain, are very numerous and capacious; and the voluntary muscles, as we have seen, (§ 192.) are largely supplied with them. As a general fact, however, the arteries distributed to the organs of organic life, and particularly those in which there is much vital action, and those in, and by which, important vital changes are affected, are larger and more numerous than those distributed to the organs of animal life. (§ 199.) The vessels of the heart which is constantly in action, are proportionally, very large; those of the

stomach are also large and exceedingly numerous, and those of the small intestine, are little less so. Moreover, the arteries are capable of being both enlarged and diminished, to a considerable extent, without actual disease. In a limb, which is habitually and vigorously exercised, the arteries become much larger, and the muscles more fully developed, than in the corresponding limb which is little employed: and on the other hand, if the same limb be suffered to remain inactive for a considerable time, the size of the arteries will be much diminished. In case of an injury, which renders it necessary to tie the principal artery of a part, the smaller arteries of the same part, immediately begin to increase in size, and in a short time they become sufficiently capacious to supply the part with nearly, or quite as much blood as it received before the injury.

§ 378. Either continuing from, or originating very near the extremities of the arterial capillaries, those of the veins, rise in equal or greater number; and, running into each other, become larger and larger, till they form numerous branches, which unite to form a large venous trunk called the *vena cava* or returning hollow. The veins from the lower, and middle parts of the body, and lower limbs, form the *ascending vena cava*; which goes up by the side of the great arterial trunk, (fig. 31. V V) and opens into the right auricle of the heart. (Fig. 43. o.) The veins from the upper part of the body, the upper extremities and the head, form the *descending vena cava*, which opens into the same cavity, near the mouth of the ascending venous trunk. (Fig. 43. q.)

§ 379. The veins anastomose, or run into each other in a net-like manner, even more frequently, than the arteries; and for the same important purpose, viz.—if the flow of the blood be obstructed in some of the veins, it readily turns aside into others, and goes on its way. The

number of branches and twigs, compared with that of the trunks, is much greater in the venous, than in the arterial system: so that, as a whole, the venous system is much more capacious, than the arterial.

§ 380. Myriads, of arterial and venous capillaries, as we have seen, (§ 287.) pass through the meshes of the great limiting membrane, and assist in forming the vasculo-nervous web, upon its exterior surface. In this web, however, the venous capillaries seem to be much more abundant, than the arterial, both in the mucous membrane, and in the skin. In the mucous membrane of the alimentary canal, according to Dr. Horner,* “the superficial layer of vessels composing this web or plexus appears to consist almost entirely of a cribriform texture of veins. The arborescence of the arteries is confined to the level beneath the venous intertexture, and is there developed to an extreme degree of minuteness; being intermixed with corresponding venous ramuscles, generally larger and more numerous, than the arteries themselves.” “The external surface of the *cutis vera* or true skin, presents as it were, an outline of the same arrangement; the venous, reticular intertexture appearing broader, not quite so perfect and more shallow and forming the papillæ.”

The Portal System.

§ 381. I have said, (§ 378.) that, the veins arising from the venous capillaries, in all parts of the body, run into each other like a net, gradually increasing in size, till they finally unite to form the great ascending, and descending venous trunks which open into the right auricle of the heart. But there is a remarkable peculiarity, in the arrangement of the veins arising from the abdominal viscera. All the veins arising from the venous capillaries of the

* See Appendix, Note A.

stomach, the spleen, the pancreas, the omentum, the small intestine, and the ascending, and transverse colon, run together, in the manner already described, (§ 378.) and form the three large veins, called the coronary vein of the stomach, the splenic, and the mesenteric veins. These, instead of advancing directly to the vena cava, unite, and form a large venous trunk, which proceeds obliquely upward, to the right, and plunges into the liver, where it suddenly divides into branches which are ramified in the manner of an artery, (fig. 24.) and where in fact, it takes the place of an artery; being distributed in the same manner and holding the same relations to the secreting surface, or the mucous membrane of the ducts, that the principal artery does in other glands. This peculiar arrangement of veins, constitutes what is called the system of the *VENA PORTÆ*, or the *PORTAL SYSTEM*:—and where these veins terminate, in the ramifications of the biliary duct, other venous capillaries arise, which, running into each other, form the hepatic veins; and these, receiving the blood from the portal veins, and from the hepatic artery, convey it to the vena cava. (Fig. 31. V.)

§ 382. The portal system has an appendage, which has hitherto exceedingly perplexed physiologists, and been the subject of a great diversity of experiment and speculation. It is called the *spleen*, and is situated in the upper and back part of the abdominal cavity, on the left side between the diaphragm, and the left kidney. (Fig. 31. S.) It is attached to the diaphragm, the stomach, and the descending colon, in a loose manner, by folds of the peritoneum, and by a great number of vessels; and hence the left extremity, or large end of the stomach, is called the splenic portion.—The spleen is extremely spongy or vascular, being formed almost entirely of blood-vessels, lymphatics, and cells, woven together by cellular

tissue, and surrounded by a very firm sero-fibrous membrane. Its artery ramifies in a peculiar manner, and abruptly expends itself on the tissues of the organ. Its veins *which are proportionally larger than in any other part of the body*, arise from the cells, and empty into the vena portæ: or rather, they constitute, as we have seen, (§ 381.) a part of the roots, of the portal trunk. Its lymphatics are very numerous. Its nerves come from the splenic plexus of the nerves of organic life, and are very small. The form of the spleen, is elliptical or oval. Its size varies much, not only in different individuals, but also, in the same individual, at different periods; and inconstantly. As a general statement, however, it is in an adult, about four inches long, three broad, and a little less than one thick. Its weight varies as much as its size, but on an average, is about eight ounces. It would be a tedious and unprofitable task, to recite the various opinions, which have been advanced, concerning the use of this organ. The conclusions to which I have arrived after a careful examination of them all, will be presented, when I come to speak of the functions of the liver and the vena portæ. (§ 460.)

§ 383. The arteries are composed of three coats. The exterior one is a dense cellular tunic. The middle one, called the muscular coat, consists of transverse circular fibres of a yellowish color, which, though they differ in appearance from the ordinary muscular tissue, are contractile, like the muscular fibre. The inner coat is a very smooth, thin, transparent membrane which has no appearance of fibres, and is continuous with that which lines the cavities of the heart.—The veins, according to some anatomists, have but two coats.—Others, perhaps more correctly, say three.—Of these, the outer one is a dense cellular coat, and is very strong. The mid-

dle one is composed of longitudinal fibres resembling the circular fibres of the arteries. The inner coat is exceedingly thin and smooth, and is very similar to that which lines the arteries and heart. Some anatomists think it is a continuation of the same. This coat, in most, or all the veins in which the blood ascends against gravity, is frequently folded so as to form a species of valves, which favor the course of the blood towards the heart, but obstruct its course in a contrary direction.

§ 384. The nerves which enter into the structure of the blood-vessels, and preside over their functions, we have seen, (§ 219. 231.) are from the ganglionic system. (§ 223.) They much more largely abound in the capillary vessels, in, and by which, all the important vital changes are effected in the blood, than in the larger trunks and branches. (§ 231.)

Lymphatic System.

§ 385. There is another set, or system of capillary vessels, of which, I have often spoken, remaining to be described, called the LYMPHATICS. These vessels are extremely minute; so that, in many parts they cannot be detected, without the help of the microscope, and even with this help, they have not yet been found in the brain, and some other parts, where, there is reason to believe, they exist. In their texture, they considerably resemble the veins.—They have two coats; of which the external one is cellular, and capable of considerable extension:—their inner coat is frequently folded, so as to form valves like those in the veins; and their walls are so thin that, these folds give them the appearance of being jointed. (Figs. 44. 45. 46.)—These vessels rise in immense numbers from almost every internal and external surface

and substance of the human body, so that, there is scarcely a particle of matter, in the whole incorporated system, which cannot be reached by them. Myriads of them rise

from the skin and mucous membrane; and their extremities form a part of the vasculo-nervous web or plexus (§ 237.) on the exterior surface of this great limiting membrane. (§ 337.) Many of these vessels, lie immediately under the external skin: (fig. 47.) others are buried in the substance of the organs, and others course along the inter-

nal membranes. In every part, they run into each other frequently, in a net-like manner: but they everywhere continue nearly of the same size. (Fig. 46.)

§ 386. At certain points, the lymphatics pass through bodies peculiar to themselves, called the lymphatic glands or ganglions. (Fig. 46.) These are small flattened bodies, of an oval or circular shape; of different sizes; varying in diameter, from one twentieth of an inch, to an inch. They are extremely vascular, and appear to consist of inextricable plexuses, of lymphatics, blood-vessels and nerves. These glands are situated in different parts of the body, but they mostly abound in the thorax.



The lymphatic vessels greatly enlarged, showing their jointed appearance. 45 shows the interior valves; 46 shows the vessels running into each other and their passage through a gland.

Fig. 47.



Shows the lymphatics, *c*, of the thigh, lying under the skin; with their glands or ganglions, *a*, at the groin.

and abdomen. Leaving these, the lymphatics proceed in a direction towards the heart, and, as it were, *converge* from all parts of the body so as to pour their contents into tubes, which open into large veins leading to the heart, near the bottom of the neck. Most of them terminate in a tube about the size of a goose quill, called the thoracic duct, which commences in the abdominal cavity, and passes up by the side of the great arterial trunk, in front of the spinal column, (fig. 48. D D) and, having ascended a short distance above the large vein of the left arm, it turns down and opens into that vein (fig. 48. S) at the angle, formed by the junction of the large vein of the head, with that of the arm. The lymphatics of the right side of the head and neck, of the

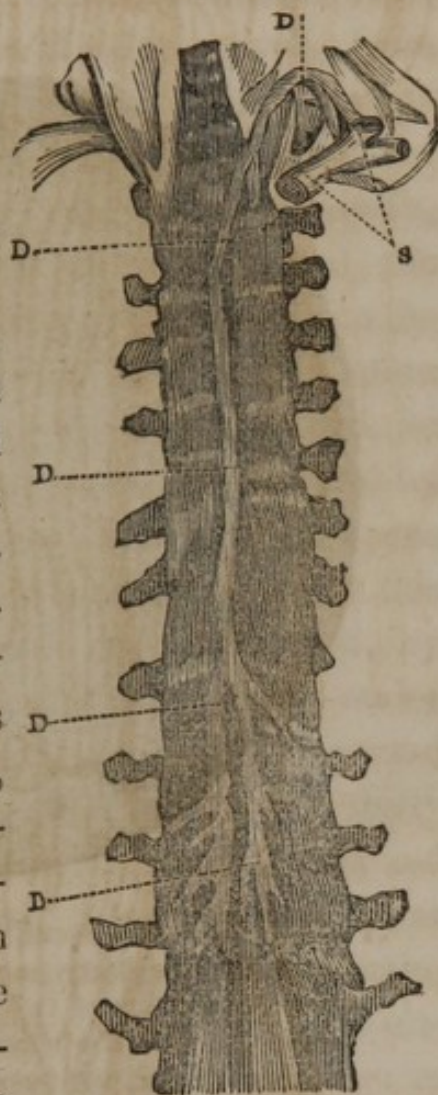
right arm, the right lung and the right portion of the dia-

phragm and liver, terminate in a short tube which opens into the corresponding vein of the arm on the right side. Besides these connexions with the venous system, many of the lymphatic vessels, as capillaries, empty into the veins in the tissues of the organs;—the lymphatics of the abdomen, terminate abundantly, in the branches of the vena portæ and also in several other veins; and lymphatic vessels terminate in veins in the lymphatic glands.

§ 387. The lymphatic system, though essentially the same in all its parts, so far as anatomical structure is considered, seems to perform a diversity of function, and therefore, it is divided, in the descriptions of anatomy and physiology, into two classes or orders of vessels. The one, consisting of the lymphatics proper, or those employed in elaborating lymph, and conveying it from every part of the body, to the thoracic duct:—the other consisting of the lacteals, or those employed in elaborating chyle from the contents of the alimentary cavity, and conveying it also to the thoracic duct.

§ 388. The lymphatics proper, as I have said, (§ 385.) pervade the whole body; arising in great numbers, from the external skin, from all the internal membranes, vessels, and cavities, and from the substance of all the

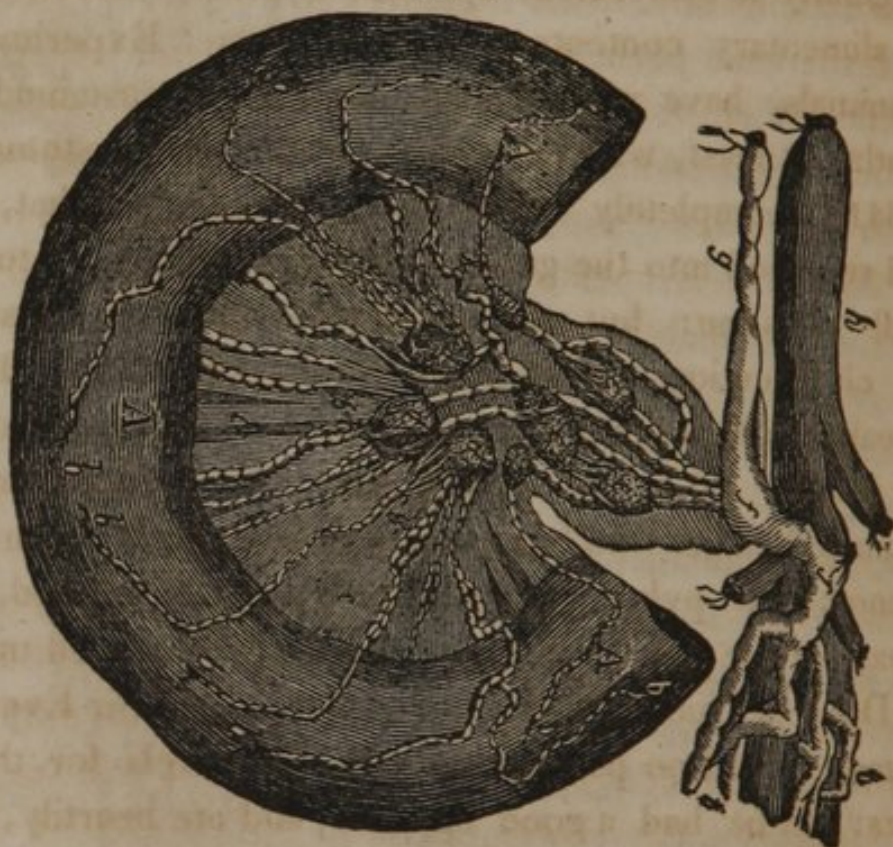
Fig. 48.



Shows the spinal column, with *D D*, the thoracic duct ascending in front of it and entering the subclavian vein at *S*.

organs. But the lacteals arise only, from the mucous membrane of the alimentary canal; and principally from the mucous membrane of the small intestine. Indeed, physiologists generally, speak of them, as arising wholly from this section of the canal, and as being much more nu-

Fig. 49.



A A is a piece of a small intestine; *b b b b* are the superficial lacteals; *c c c* is the mesentery, a delicate, but firm membrane, consisting of two layers, by which the intestines are connected with the spine and within the folds of which the deep-seated lacteals pass; *d d d* and *e e e*, the two sets of absorbent glands; *f f*, the receptacle of the chyle; *g*, the thoracic duct; *i i*, the lymphatics, coming from different parts of the body; *h*, the aorta, the great artery.

merous in the upper, than in the lower portion of it. But it must be remembered that, there is no appreciable difference in structure, between a lacteal and a lymphatic vessel, and that all, which distinguishes the one from the other, is that the one, in the regular performance of its office, elaborates and conveys chyle and the other,

lymph, which in many respects, nearly resembles chyle. As a general statement, they are all assimilating organs; and wherever they may be situated, if they elaborate chyle from alimentary substances, and convey it to the thoracic duct, they are in fact lacteals. And it is very certain that, chyle may be, and there is reason to believe that, it regularly is elaborated, by some of these vessels, from the alimentary contents of the stomach. Experiments on animals, have proved that they can be sustained for months, at least, with the pyloric orifice of the stomach, (§ 341.) completely closed by a ligature; so that, the food received into the gastric cavity, cannot pass into the small intestine: but the processes of chymification and chyfication are effected by the stomach and its lacteals, and the excrementitious matter is evacuated by the mouth. (§ 481.) There have also, been instances of human beings, who have been sustained for years in this manner; the pyloric orifice being entirely closed, by disease of the parts. “Gen. Grose, who served under the Duke of Cumberland, in Flanders,” says Sir Everard Home, “had no passage through the bowels for thirty years; yet he had a good appetite, and ate heartily, and was a healthy and able-bodied man. In two hours after eating, he threw up the contents of his stomach, remaining undisposed of.” Chyle may be, and probably is elaborated to some extent, also from the large intestine, or colon. (§ 338.) It is not therefore, strictly correct, to say that, the lacteals arise only from the small intestine. For important reasons, however, it is nevertheless true, that they mostly abound in this section of the alimentary canal, and are most numerous in the upper two-thirds of this section; or in the duodenum and jejunum. (§ 338.) Leaving the alimentary canal, (fig. 49.

A A) the lacteals (fig. 49. *b b*) proceed across the

mesentery. (figs. 36 and 49. *c c*) (§ 350) converging towards the back-bone, and, having passed through a number of their ganglions, (fig. 49. *d e*) here called the mesenteric glands, they terminate in the portion of the thoracic duct, (§ 386.) called the receptacle of the chyle. (Fig. 48. *f*.) According to some anatomists, most or all of the lacteals, traverse a portion of the liver, before they reach the thoracic duct.

§ 389. The lymphatic system may be considered as an appendage to the venous system, furnishing it with all the assimilated materials, by which the body is nourished, as well as conveying to it, the effete substances, which are to be eliminated from the vital domain. These two systems are connected, as we have seen, (§ 386.) at several points, and the structure of the lymphatic vessels, much resembles that of the veins. (§ 385.) Moreover the venous capillaries and the lymphatics appear, to some extent, to reciprocate in function; and the lymphatics always empty their contents into the veins.

§ 390. In the lymphatic system, as in the arterial, and venous, the nerves of organic life supply the nervous tissue of all the vessels and preside over all their functions; (§ 230.) and in these vessels, as we shall see, some of the most important vital changes take place.

The Circulating Forces.

§ 391. Concerning the agencies and forces, employed in the circulation of the blood, and other fluids, in the vessels just described, physiologists have differed widely in opinion. Some have asserted that, the heart alone, exerts all the force, by which the blood is circulated: and that, the arteries and veins have no other agency in the general function, than as elastic, conducting tubes,

to adapt their capacity to the volume of blood, which they contain:—and accordingly, the advocates of this theory, have denied all contractility to the arteries, and estimated the contractile power of the heart, as equal to many hundred pounds.—On the other hand, it is contended, by others, that, the heart simply injects the blood into the arteries, with a very small force; and the arteries, by their active and vigorous contraction, carry on the circulation, as in those animals which have no heart.—Others again, with more correctness, take the middle ground, between the two extremes.

§ 392. According to the best experiments, and estimates, which have been made, on this point, the left ventricle of the heart, acts with a force of six pounds on the square inch. This ventricle, when distended, has about ten square inches of internal surface, and consequently, the whole force exerted by it, in throwing the blood into the aorta, is about sixty pounds. That the arteries are very elastic, and that they have the power of adapting their capacity to the quantity of blood in them, is, I believe, admitted on all hands; and it is generally acknowledged that, when animals bleed to death, and also after the heart has ceased to act, in what is called natural death, the arteries continue to diminish their capacity, till all the blood is pressed out of them.

§ 393. We have seen (§ 376.) that, it is a general law of the organic economy, that all vital action is attended with an expenditure of vital power, and waste of organized substance; and that, these are replenished by arterial blood. It is also, a general law of the organic economy, that, all increased action of a part, is attended with an increased flow of blood to the part. But this local increase of blood, does not depend on the action of the heart; nor on the general action of the arteries. It is the

effect of the special action of the arteries of the part, acting under the influence of the special centre (§ 219.) which presides over the organic function of the part.—It is very evident, that, in particular organs, the blood-vessels, and especially the arteries are, to some extent, under the control of the special centres which preside over the functions of those organs. Thus, when food is introduced into the stomach, the vessels of that organ soon become injected, sometimes even to turgescence, without any increased general action of the heart and arteries. The nerves of organic sensibility (§ 230.) perceiving the presence and qualities of the food, immediately inform the special, presiding centre, and this, instantly, throws its stimulating influence upon the arteries belonging to the stomach, and causes them to fill themselves, and to inject the secreting vessels, with an increased quantity of blood: and, if the substance introduced into the stomach, be of a highly offensive character, the quantity of blood pressed into the vessels is often very excessive, producing great congestion.

§ 394. Both the heart and the arteries therefore, are actively concerned in the general circulation of the blood; while the special increase of blood in particular parts, depends entirely on arterial action. At every contraction of the left ventricle of the heart, the aorta is somewhat dilated; but it instantly contracts on the blood, and presses it onward, through the branches, into the capillary extremities; (§ 374.) the blood being prevented from returning into the ventricle by the valves at the mouth of the aorta. (§ 369.) The branches act in the same manner as the main trunk. But both the aorta, and the large branches issuing immediately from it, are probably much less active agents in the function of circulation, than the
" r twigs and especially the capillary vessels.

(§ 395.) In regard to the venous circulation, some physiologists have thought that, the force exerted by the heart, is sufficient to effect the motion of the blood in the veins.—Others have supposed that, the propelling action of the capillary vessels, the throbbing of the arteries against the veins, the suction of the heart by the dilatation of its auricles, and atmospheric pressure connected with respiration, (§ 365.) are all concerned, as moving forces, in the venous circulation. But the texture and construction of the veins (§ 383.) and the physiological analogy of the whole vital economy, show that the veins, as well as the capillary vessels, possess the power of propelling the fluids which circulate in them.

Organs of Special Sense.

§ 396. The parts which remain to be described, and which in the order of development (§ 174.) appear later than the internal organs, are the apparatuses to which the nerves of special sense are distributed; and the hair and nails. The organ of touch, I have already described. (§ 242. 253. 287.) It is extended over the whole external surface of the body, and in fact, may be said to pervade the whole body; because, at every point we are exposed to the action of those tangible properties of things, which may prove injurious and destructive to life. In man however, the ends of the fingers are more particularly appropriated to the voluntary function of touch, or feeling; and here, most thickly cluster those little tufts, or velvety eminences formed principally, of the minute extremities of the nerves of sense, called the papillæ. (§ 287.) The sense of touch or feeling, is the primary animal sense, and exists, in a greater or less degree, in every living animal. (294.) It is determinately estab-

lished upon the constitutional laws of relation, existing between the living body and external substances and things, and with strictest reference to the physiological interest of the body.

Organ of Taste.

§ 397. The nerves of taste, or the gustatory nerves, I have said, (§ 254.) are distributed to the mouth and throat; but the papillæ in which their extremities terminate, most largely abound in the mucous membrane which covers the end of the tongue. This sense is founded on the alimentary wants of the vital economy, and determinately established on the constitutional laws of relation between the physiological interests of the body, and its appropriate alimentary substances.

Organ of Smell.

§ 398. The sense of smell (§ 294.) is nearly allied to that of taste, in the character and extent of its functional relations, and responsibilities. It is founded on the respiratory and alimentary wants of the vital economy, and determinately established on the constitutional laws of relation between the physiological interests of the body, and the qualities of external things, which may effect those interests, through the functions of respiration and alimentation; or through the medium of the lungs and stomach.

§ 399. The olfactory nerves, or the nerves of smell, I have described, (§ 251. 252.) They proceed from the centre of animal perception, (§ 280.) and terminate, in the vasculo-nervous web, (§ 287.) on the exterior surface of the mucous membrane which lines the nostrils, and the cavities connected with it. There are four

principal cavities; two of which, are situated in the upper jaw, (one on each side of the face,) and two in the prominent part of the frontal bone, directly above the eyes: and all of these communicate with the nostrils. Whether the sense of smell, is as extensive as the mucous membrane which lines these various cavities and passages, or is limited to the superior part of the nasal fossæ, is a question, on which, physiologists are not agreed. Some experiments, and pathological facts, seem to prove that the olfactory sense is limited to the superior part, of the nasal canals where the olfactory nerve is mostly distributed; while comparative anatomy and physiology favor the contrary opinion;—the cavities being most largely developed in those animals which are most remarkable for their power of smell.

§ 400. It is essential to the integrity, of the faculties of taste and smell, that, the parts to which these senses belong, should be continually moistened. If by disease, or otherwise, the mucous membrane of the mouth and nose, becomes perfectly dry, the senses of taste and of smell are for the time, entirely abolished. Hence, in a healthy state and condition of these parts, the mucous membrane is at *all times*, moistened and lubricated, by its own exhalation and secretion. (§ 339.) But this is not peculiar to these parts. Throughout the whole extent of the mucous membrane and external skin, the same condition is essential to the functional integrity of the nerves and vessels, which form the vasculo-nervous web, on the exterior surface. (§ 287.) The situation of the mucous membrane, in the nasal cavities, however, renders it peculiarly liable to become dry; and hence, there seems to be a necessity for a very copious supply of lubricating fluid: and it may therefore, be true, as has been suggested by some physiologists, that, the office of the cavities

associated with the nasal canals, is to secrete mucus for those canals.

Organs of Hearing and Sight.

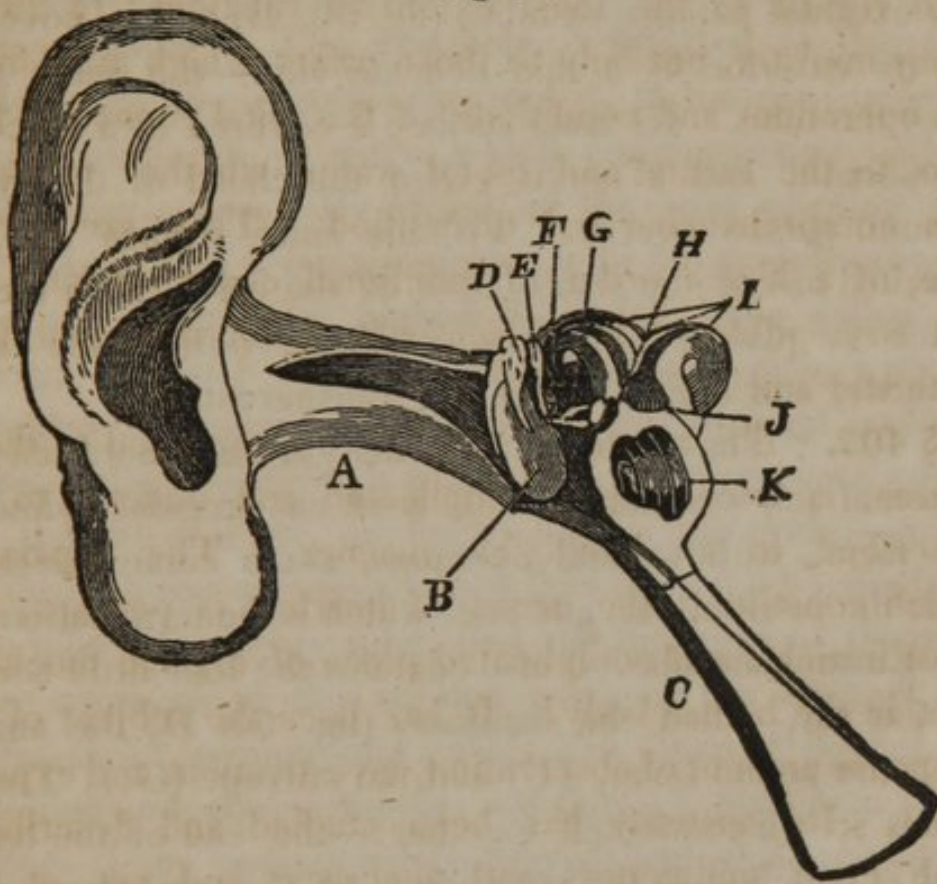
§ 401. The sense of hearing and the sense of sight are founded on the general wants of the organic system, with whatever powers and capacities it may possess; and with regard to the most extensive relations. (§ 294.) They minister, not only to those wants, which arise from the operations and conditions of the vital economy, but also, to the mental and moral wants, whether more or less comprehensive and diversified. They are therefore, of a higher order of functional character, and are not susceptible of being sensualized and depraved like taste and smell.

§ 402. The organism specially appropriated to these senses, is exceedingly complicated and difficult to be described, in an intelligible manner. The apparatus which constitutes the organ of hearing, is perhaps, the most intricate and complicated piece of organic mechanism, in the human body. It has been the subject of an immense amount of observation, investigation, and experiment. Its anatomy has been studied and described, with great minuteness and accuracy; and yet, at the present moment, very little is known of its physiology, except the bare fact, that, it is the organ of hearing. I shall therefore, only give a very brief, and general description, of this organ, and refer the curious reader, to the minute anatomists, for further information, respecting it.

§ 403. "The organ of hearing may be divided into the outer, the inner, and the middle parts, and the auditory nerve. (Fig. 50.) The outer part consists of the external

ear, and the tube, which leads to the membrane of the tympanum. The external ear is composed chiefly, of cartilage, covered with a delicate skin, and supplied with nerves and blood-vessels. When well formed, it inclines a little forward, and is admirably adapted to collect sound, which it transmits through the tube that leads to the membrane of the tympanum. (Fig. 50. A.) This tube is

Fig. 50.



A map of the ear. *A*, the external auditory tube; *B*, the membrane of the tympanum; *C*, the Eustachian tube; *D*, the hammer; *E*, the anvil; *F*, the round bone; *G*, the stirrup; *H*, the oval opening; *I*, the semicircular canals; *J*, the vestibule; *K*, the cochlea.

nearly an inch in length, and is formed, in part, of cartilage, and in part of bone. It has a number of small glands or follicles which secrete the wax, (§ 333.) and its entrance is guarded by stiff hairs, to prevent insects and other foreign bodies from entering. When it is recol-

lected however, that, the membrane of the tympanum has no opening, it must be apparent that the apprehension which is so often expressed lest insects should penetrate into the head, is wholly groundless.

§ 404. “The middle part of the organ of hearing, embraces the tympanum and its membrane, the small bones of the ear, and the Eustachian tube. (§ 340.) The membrane of the tympanum is situated at the bottom of the external passage or tube, (fig. 50. B) and is covered on its exterior by a thin delicate skin—the same that lines the tube. Its inner surface is covered by a mucous membrane, and a nerve, called the chord of the tympanum, passes over it. To this inner surface also, is attached one of the small bones of the ear. This membrane is placed obliquely, inclining downwards and inwards; and is tense, thin and transparent.

§ 405. “The tympanum is a cavity situated between the external and internal ear. It is of an irregular cylindrical form, with several openings, some communicating with the internal ear, and one, which is the termination of the Eustachian tube. It also contains the four little bones of the ear, called the hammer, (fig. 50. D) the anvil, (E) the round bone, (F) and the stirrup. (G.) These bones are all connected together:—the end of the hammer is attached to the membrane of the tympanum, and the stirrup is placed over an opening which leads to the internal ear. Muscles of very small size are inserted into these bones, and move them in various directions. The Eustachian tube, (C) leads from the cavity of the tympanum to the back part of the throat. (§ 340.) It is about two inches in length;—partly bone, and partly cartilaginous; and is lined by a mucous membrane. Its two extremities are not of the same size, the one opening into the throat, being somewhat larger than the other.

§ 406. "The internal ear is situated in a part of the temporal bone, near the base of the skull, which, from its stony hardness, is called the petrous portion. It is composed of three parts; the cochlea, (Fig. 50. K) the vestibule, (J) and the semicircular canal. (I.) The cochlea is so called, from its resemblance to the shell of a snail. It is situated near the entrance of the Eustachian tube, and is the most anterior part of the internal ear. It communicates with the cavity of the tympanum and the vestibule. The vestibule is situated in the central part of the internal ear, and is, as its name imports, a sort of porch or entry, which communicates with all the other parts. By means of the oval opening (the *foramen ovale*) it communicates with the tympanum; and over this opening, is placed the small bone called the stirrup (*stapes*.) It has communications also, with the cochlea, the semicircular canals, and internal auditory tube,—the one through which the auditory nerve passes to the internal ear, on its exit from the brain;—and it is through the openings which lead from the vestibule, to the internal auditory tube, that the branches of the auditory nerve go to the various parts of the internal ear. The three semicircular canals are situated behind the cochlea and the vestibule, and they all terminate in the latter. They contain a dark grayish semi-fluid substance, the use of which is unknown.

§ 407. "The auditory nerve, (§ 251. 252.) passes into the internal auditory tube and is subdivided into numerous small filaments, which pass through the minute openings, and are distributed to the semicircular canals, the cochlea, and the vestibule, terminating in the form of a pulp."*

§ 408. In regard to the office of these several parts,

* Hayward's Outlines of Human Physiology.

in the general function of the organ, nothing is known with certainty. The membrane of the tympanum has frequently been ruptured without impairing the faculty of hearing. All the small bones of the ear, except the stapes, have also, been removed by disease, and still the faculty of hearing remained. These facts however, while they prove that, those parts are not immediately essential to the function of hearing, do not prove that, they are not most perfectly adapted to the permanent economy, and functional integrity of the organ. The membrane of the tympanum is probably designed mainly, to shut out foreign substances from the inner chambers of the ear, and thus keep the auditory nerve, which is expanded in those chambers, in the most delicate and susceptible condition, and at the same time, it is most perfectly fitted to transmit vibrations to that nerve.

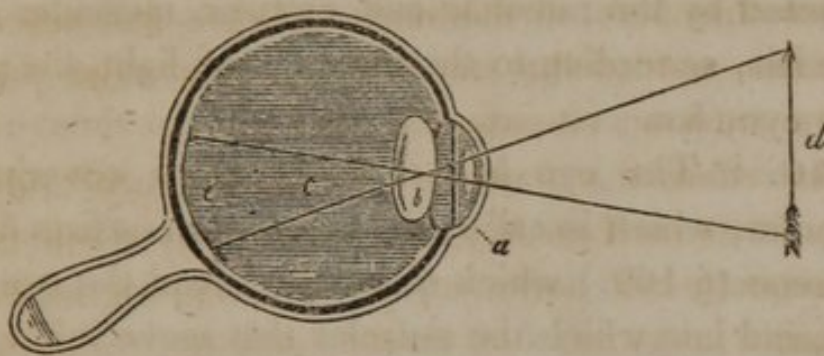
Concerning the function of the auditory and other organs of sense I shall speak more fully when treating on the intellectual and moral powers, and on the laws of relation.

Organ of Sight.

§ 409. "The apparatus which constitutes the organ of vision is somewhat less complicated than that of hearing, and the uses of its various parts are much better understood. The eye is an optical instrument of the most perfect construction. It is of a globular form, composed of a number of humors, so called, which are covered by membranes, and enclosed in several coats. (Fig. 51.) These humors are called the vitreous, (*c*) the crystalline, (*b*) and the aqueous. (*a*) The vitreous, which takes its name from its resemblance to melted glass, is situated in the back part of the eye, and constitutes the

greater portion of the globe. It is of the consistence of the white of an egg, and is contained in numerous small cells, formed in a membrane of great delicacy, which also covers it. On its anterior surface, there is a slight depression, and in this, is situated the crystalline humor or lens. (Fig. 51. *b*.) This is a body of considerable thickness and strength; and has the form of a double convex lens:—the convexity of the two sides however, is not the same. It is placed in a perpendicular direction immediately behind the pupil, and is kept in its situation by a membrane which is called its capsule.

Fig. 51.



A section of the human eye. *a*, the aqueous humor; *b*, the crystalline lens; *c*, the vitreous humor; *d*, is an object from which the rays of light go off, and as they enter the eye, they are refracted by the different humors, and form an inverted image, *e*, on the retina.

In front of the crystalline lens, and occupying the whole of the anterior part of the eye, is the aqueous humor; (*a*) the only one of the three, which is properly called a humor. It is composed principally of water, with a few saline particles, and a very small portion of albumen. —A curtain with an opening in its centre, floats in the aqueous humor, but is attached to one of the coats of the eye at its circumference. This curtain is called the iris, and the opening in it is the pupil. It derives its

name from the various colors it has, in different individuals; and it is the color of the iris that determines the color of the eye. Some have thought the iris to be a mere continuation of one of the coats of the eye; others have supposed it to be a peculiar texture; and others again, are of opinion that it is formed in part from one of the coverings of the eye, and that it has also a layer peculiar to itself. The back part of the iris, is called the uvea. The iris divides the space between the crystalline lens and the front of the eye, into two parts, called the anterior, and posterior chambers, the former of which, is much larger than the latter.—All the light admitted to the eye passes through the pupil, which is dilated and contracted by the radiating and circular muscular fibres of the iris, according to the intensity of light, the power of the eye, &c.

§ 410. “The eye has three coats or coverings.—The outer, which is called the sclerotic, is a firm fibrous membrane (§ 169.) which serves to defend the eye from injury, and into which the muscles that move it in various directions, are inserted. It extends over the whole of the eye, except the fore part, which is covered by a transparent membrane. It is the sclerotic coat which is commonly called the white of the eye.—Within the sclerotic coat, is situated the choroid coat. It is a thin, delicate membrane, composed mostly, of blood-vessels and nerves. It is loosely attached to the sclerotic coat, which it covers, and is of the same form and extent. On the inner surface of the choroid coat is found a dark substance called the black pigment, which is of great importance in the function of vision.

§ 411. “The inner coat of the eye, if it be not an expansion of the optic nerve, is composed of nervous filaments, and is called the retina. (§ 252.) It is of the same

extent as the other coats, surrounding the whole globe of the eye, except the circular opening in front, to the edge of which, the circumference of the iris is attached, by a band called the ciliary ligament, and over which is placed the convex transparent membrane which from its resemblance to horn, is called the cornea."

§ 412. The optic nerves have been fully described, (§251. 252.) "They do not enter the eyeballs in the centre, but a short distance from it towards the nose. The balls are situated in deep bony sockets, with prominences above, on which are placed the eyebrows. They are furnished with lids which can shut so closely as to exclude not only foreign bodies, but even light. There is also an apparatus, by which the external surface of the balls is moistened, and foreign particles washed away. The eyelids have a thin delicate skin on the outside, muscular fibres beneath, and a cartilage on their edges. They are lined by a mucous membrane which passes from them over the anterior part of the eye, and is called the tunica conjunctiva, because it is the tunic which connects the eyeballs with the lids. It is loosely attached to the eyelids, so as to allow free motion in all directions. In the edges of the lids are numerous small glands or follicles which secrete an unctuous substance that is probably expended on the eyelashes."*

§ 413. The fluid which continually moistens the eyes, is secreted by the lachrymal glands, which I have described. (§334. 345.) These glands are situated within the orbit, at the outer angle of each eye, (fig. 52. *a*) and constantly supply the eyes with moisture, not only when they are open, and in action, but also when closed, and quiet in sleep. The fluid thus secreted, having per-

* Hayward's Outlines of Human Physiology.

formed its office, passes from each eye through two small openings, (one in each lid) called the puncta lachrymalia, (fig. 52. *c c*) and is thence conveyed into

Fig. 52.



a, the lachrymal gland; *b*, its several ducts, to convey the tears to the eye; *c c*, the puncta; *d e*, the nasal duct.

the nose by a canal on each side called the nasal duct, (fig. 52. *d e*) which is lined by a mucous membrane. These canals, from inflammation and other causes, frequently become obstructed, and then the moisture accumulates in the eyes, till it flows over the under lid.—When the lachrymal glands are much excited, by irritations of the eyes or nose, or by strong emotions of the mind, or morbid sensi-

bilities, they pour their fluid into the eyes, far more rapidly than the nasal ducts can convey it to the nose, and consequently, it overflows the under eyelids and runs down upon the cheeks, and is called tears.

§ 414. Each eye has six muscles, which are attached to the outer coat, and which turn it in every direction. These muscles are among the most curious parts of the visual apparatus.—The nerves which convey the stimulus of voluntary motion to these muscles, have been described. (§ 248. 249.) Those which impart the sense of touch, or feeling, to the eyes, ears, nose and mouth, are from the trifacial, or the fifth pair of the old anatomists, and have also, been fully described. (§ 254.)

§ 415. So far as the eye is considered as a mere optical instrument, the philosophy of vision is easily understood, and explained; but when considered as a living, animal organ of visual perception, the philosophy of its function is much more intricate, and has hitherto greatly perplexed the learned, and given rise to many ingenious speculations and theories: none of which, however, has been free from insuperable objections.—It is not consistent with my general plan, that I should enter extensively, into an explanation of the mechanical, or physical philosophy of vision. The properties and laws of light and other principles belonging to the science of optics, must be studied elsewhere: but the physiological and psychological philosophy of vision, I shall endeavor to explain fully, when I come to treat on the functions of the intellectual and moral faculties.

§ 416. It is a matter of common knowledge, that, light is the medium of vision. If any one will take one of the glasses of a pair of spectacles of considerable magnifying power, and cut a hole in a window-shutter, just large enough to receive the glass, then close the shutter, and exclude all light from the room, except what passes through the spectacle glass, if the sun is shining brightly, the rays of light will be seen in the darkened room, passing from the glass, and converging or drawing together, till they all meet in a point or focus, and then diverging or spreading out, beyond this point:—the diverging rays forming exactly the same angle, at the focal point, that the converging rays do. At this focal point all the rays coming through the glass, cross each other; so that, the top rays at the glass, are the bottom ones beyond the point, and the bottom rays at the glass, the top ones, beyond the point: and in the same manner, all the rays cross at the point. Now if a sheet of white paper, be

placed a little beyond the focal point, a beautiful miniature image will appear upon it, of the trees, animals, or whatever else the rays of light may come from, which pass through the glass: and this image will have all the colors and hues of the objects, from which the rays of light are reflected. But the image upon the paper will be upside down, and turned side for side; and this will be caused by the crossing of the rays of light, at the focal point: and the rays of light are made to cross each other, by passing through the glass, in the shutter, which is thicker in the centre than at the circumference, and, being a more dense or solid substance than the atmosphere, bends the rays towards each other, as they pass through it. The rays will be bent towards each other more or less, in passing through the glass, according as the glass is more or less convex; or in proportion as the centre of the glass is thicker than its edge at the circumference; and consequently, the more convex the glass, the sooner will the rays, which pass through it, come to a point, and cross each other. And, if instead of a spectacle glass, a small glass globe, filled with water, be placed in the hole, in the window-shutter, the rays will cross and diverge before they get through it, and the image will be thrown upon the back part of the globe.

§ 417. This is a brief description of what is called a *camera obscura*—or darkened chamber; which is considered the best illustration of the eye, and of the physical philosophy of vision. The interior of the eye is the darkened room; the cornea is the perfectly transparent window glass; the iris is the shutter, the pupil is the hole through which the rays of light enter, and the aqueous, crystalline, and vitreous humors constitute a lens of so great a convexity that the rays cross and diverge before they get through the globe, and throw their

inverted image upon the retina, (fig. 51.) where, according to the received theory of vision, the mind perceives it, not as the image of external things, but as the things themselves, which the judgment, somehow or other, contrives to get right end upwards. But of this, more hereafter.

§ 418. Sometimes, either from the shape of the eyeball, or from the shape and situation of the crystalline lens, the rays of light cross too near the cornea, (§ 411.) and the image upon the retina, is confused and indistinct. This is the case with near-sighted people. When the eye becomes enfeebled by old age, or disease, either from the falling back of the crystalline lens, or the flattening of the ball, the focal point is formed too near the retina, and by this means also, the image is rendered imperfect and confused. In the former case, spectacles with concave, and in the latter with convex glasses, assist the eye in forming its focus at the proper distance from the retina:—the concave glasses, by spreading out the rays before they enter the pupil, and thus preventing their crossing so soon after they have entered; and the convex glasses, by bringing the rays nearer together before they enter the eye, and thus causing them to cross sooner after they have entered. In the eye however, as in every other part of the vital organism, *the physiological powers are always impaired by a dependence on artificial means*: and though it may sometimes be convenient, and even necessary, to have recourse to the use of glasses, to regulate the focal distance of the eye, yet it is certain that, thousands of eyes are permanently injured, where one is benefited by such means.

§ 419. The eye in a healthy and vigorous state, undoubtedly has the power of adjusting its own focal distance, either by the movement of its crystalline lens,

or in some other manner: and if man were always obedient to the laws of his nature, he would never need artificial means to improve his vision, though his life were prolonged to a thousand years. But it must ever be remembered, that, neither the eye, nor any other part of the living body, can be diseased or cured independently of the common vital economy of the whole organized system; and that the physiological interests of each particular part are inseparably connected with those of every other part: so that the organs of sight, of hearing, of smell, of taste, and of touch, and all the other constituent parts of the living whole, are dependent for their individual welfare, on the common weal of the general assemblage.

Hair and Nails.

§ 420. The hair and nails are generally spoken of, as appendages of the skin, but they are as dependent on an appropriate organism, consisting of vessels, nerves, &c. for their production and sustenance, as any other part of the living body. Every hair has its root, which is situated immediately under the skin, and consists of a small oval pulp, invested by a sheath, or capsule, and supplied with vessels and nerves. The shaft which rises above the surface of the skin, consists mostly of a horny substance resembling that of the epidermis. (§ 287.) In its origin, it is tubular; the inner part being occupied by the pulp: but the pulp extends only to that portion of the hair, which is in a state of growth, and never rises above the surface of the skin. As the shaft is prolonged from the surface, therefore, its cavity is either gradually obliterated, or is filled with a dry pith or spongy substance which is supposed to contain air.

§ 421. The health and vigor of the hair depends entirely on the health and vigor of the root; and this, as a living organ, is a constituent member of the general system; and its vital interests are inseparably connected with the general welfare of the body. Every injury done to the digestive organs, every instance of gluttony or intemperance, or sensual excess of any kind, and every violent excitement or emotion of the mind, such as anger, fear, grief, &c. immediately and powerfully affect the roots of the hair, and through them, the health of the hair itself. Violent grief has covered many a head with gray hairs, in a very short time: and violent paroxysms of fear have produced the same effect in a few hours; and so has excessive sensuality. But the abuses of the stomach, or dietetic errors are probably the most general causes of the unhealthiness of the hair, and of baldness, in civic life. When the health of the roots of the hair begins to decline, the bulb diminishes in size, the vessels lose their power of supplying nourishment, the coloring matter ceases to be deposited, and the hair soon becomes gray or white. The hair therefore, though its stem or shaft above the surface of the skin is destitute of vessels and nerves, and has no sensibility, ought nevertheless to be regarded, and treated as a living part of the living body; and its health should be cherished, and its disease avoided or remedied, only upon principles, and by means, which are in perfect accordance with the general laws of life and health; and favorable to the well being of the whole system. All external applications, except, in so far as they contribute to the health and vigor of the roots by the cleanliness and exercise of the skin, are entirely useless, and in most cases decidedly injurious. In a healthy state of the hair and its appropriate organs it is always supplied with an oily secretion or halitus, with which it is anoint-

ed, and it can never be benefited, but is generally injured by the application of any other unction. A proper regard to all the physiological laws of the body, is the only genuine prophylactic for the hair, and the only ground on which any one can reasonably hope to restore the natural covering to a bald head.

The Nails.

§ 422. The nails, like the hair, though composed of an insensible horny substance, destitute of nerves and vessels, have their appropriate organs or roots, by which they are produced and sustained, and by which also, they are physiologically associated with all the living organs and parts of the body, and brought under their common laws of life and health. They do not however appear to sympathize, so directly and powerfully, in the particular affections of the body, and mind, as the hair; but they are always involved in the general and permanent physiological conditions of the system: being more or less moist and pliable, or dry and brittle, according to the general state of health: and in some instances, they are entirely destroyed by a general disease of the body, or what is probably more correct, by the medicinal substances, employed to cure the disease.

§ 423. The truth is, that every part of the living body, even the cuticle or epidermis, (§ 287.) is either a living substance, or so closely connected with living organs, and so immediately dependent on vital functions and conditions, that, it is brought under the general laws of the vital domain, and kept in its best condition, by the health and integrity of all the organs of the system: and therefore, ought always, to be treated with reference to health and disease, as a constituent portion

of the living body; which cannot be either benefited or injured, without in some measure, correspondently affecting the whole vital economy.

LECTURE VIII.

Exercise of the voluntary powers in procuring food—Mastication and deglutition—Gastric digestion—Beaumont's experiments—Saliva and gastric juice, solvent fluids—True chymification only effected by the living organs—Function of the pylorus—Importance of the stomach—Character of the chyme—Indigestible substances, how disposed of by the stomach—Not all the properties of the food digested—Time employed in digestion—How fluids are disposed of—Absorption, by what vessels performed—Fluids rarely descend into the small intestine, unless strongly offensive to the absorbents, &c. as alcholic liquors when first used, &c.—Function of digestion, on what its integrity depends—Chyme, how presented to the lacteals—Chyle, where formed and by what vessels—None in the alimentary cavity—Use of the pancreatic fluid—Use of the bile, and functional character of the liver—Portal system—Communication between the liver, kidneys, lungs, skin, &c.—Alcholic liquors, why not at first admitted into the general circulation—Foreign substances found in the portal blood—Use of the spleen—Oily matter and acids in the food require bile—Chyle secreted—its nature—Process of chyfication mysterious—Chyle the same whatever the food—Function of the mesenteric glands—Globules of the chyle invested with tunics—Passage of the chyle to the lungs—Function of respiration—Blood circulated for the nourishment of the body—Quantity of blood in the body, frequency of pulse, &c.—Vitality of the blood, character of its globules, &c.—Saline property of the serum—Foreign properties in the blood—Animal heat—Nutrition—Secretion—Adipose matter, its use—Size of the body determinate—Decomposition—Depuration—Wear, expenditure and disease.

§ 424. HAVING taken a general survey of the materials and construction of the human body, and attended to the

minute anatomy of its several organs, as fully as is necessary in order to a clear and correct understanding of the physiology of the system, we are prepared to enter upon the more interesting and pleasing study of vital function, or the offices performed by the several parts of the body as living organs, in the wonderful economy of the vital domain.

§ 425. Let us then contemplate the living, human being, rising from the Creator's hand, and awakening to the consciousness of his existence, and of his wants; and to a perception of the external world.—He soon feels that special sensation which we call hunger, or the instinctive desire for food. This sensation, physiologists have attempted to explain in various ways, and most of them with much more fancy than truth. My own views in regard to it, will be presented when I come to speak of the proper times of eating.—Prompted by this instinctive impulse, man exercises his voluntary powers for the supply of the want. He looks abroad, and beholds the fruit hanging upon the drooping bough of the tree, and by a voluntary control of his lower limbs he moves forward to the object of his vision. The specific odor of the fruit freighting the air which he breathes, is brought into contact with his olfactory nerves, (§ 399.) and he instinctively perceives, by the special sense of smell, that it is good for food. By a voluntary control of his upper limbs, or organs of prehension, he puts forth his hand and seizes the fruit, and places it between his teeth, with which, by a voluntary exercise of the various appropriate muscles attached to his under jaw, he cuts and mashes it into minute particles. The instant this process is commenced, the special sense of taste (§ 397.) perceives another specific quality of the food, and corroborates the testimony of the sense of smell. And while the process

of mastication is going on, the mucous membrane of the mouth, secretes its glairy and lubricating fluid, (§ 333. 339.) to shield its delicate little organs, (§ 287.) from too rude a touch, and to facilitate the movements of the food upon its surface, and its passage into the stomach. At the same time, also, the salivary glands (§ 340.) secrete from the arterial blood, and pour into the oral cavity, a copious supply of a bland, tasteless fluid called the saliva, to be thoroughly mixed with the aliment, by the action of the teeth.

Mastication, Insalivation and Deglutition.

§ 426. The functions of the oral cavity, are generally regarded as merely preparatory for deglutition, or swallowing; and the salivary fluid is considered as simply intended for this purpose. But this is incorrect. The mucous secretions and serous exhalations of the mouth and fauces and œsophagus (§ 339.) are abundantly sufficient for all the purposes of lubrication and dilution, necessary to prepare the food for deglutition. The saliva is truly *a solvent fluid*, and designed to act as such upon the alimentary contents of the oral cavity: and always, when the function of mastication is properly and thoroughly performed, the process of assimilation or digestion commences in the mouth:—the change, effected there, being greater or less, according to the perfectness of mastication, the length of time the food is detained in the mouth and the healthiness and purity of the salivary fluid. And it is certain that, the change *can be* carried so far as to afford nutrient matter to the lymphatics (§ 385. 387.) of the parts.—By hasty and imperfect mastication therefore, a fourfold injury is done to the stomach. 1. It compels that organ to receive the

food more rapidly than is consistent with the welfare of its own physiological economy. (§ 429.) 2. It compels the stomach to secrete a larger quantity of solvent fluid, than would be necessary if the functions of the mouth had been properly performed. 3. It compels the stomach, at great inconvenience, to reduce by maceration, those masses, which ought to have been broken down and finely comminuted by the teeth: and 4; by increasing the duration and difficulty of gastric digestion, it increases the expenditure of the functional powers of the stomach, and thus causes a greater degree of vital exhaustion, in that organ, tending to debility and disease.

§ 427. When the food is prepared for deglutition, it is gathered back upon the arch of the tongue, whence it is suddenly launched into the pharynx (§ 338. 340.) and passes into the œsophagus or meatpipe, by which it is conveyed into the stomach. In its transition from the arch of the tongue to the meatpipe, the food, it will be remembered, passes by several orifices and directly over the mouth of the windpipe. (§ 340.) But it must not be permitted to enter any of these orifices, nor cause any considerable interruption to respiration: and therefore, the orifices are closed during its transition; and its passage is very rapid: and hence, the function of deglutition or swallowing, is somewhat complicated, and requires the perfect co-operation of all the parts concerned. At the instant the food is launched from the arch of the tongue, the muscles of the pharynx (§ 347.) contract, shortening that organ, and raising up the larynx: (§ 356.) at the same instant, the veil of the palate is pressed back, and closes the nasal canals, and the tubes coming from the ears, (§ 340.) the epiglottis (§ 340. 354.) shuts down and closes the glottis, or mouth of the windpipe, and the pharynx darts up, as it were, and seizes the descending

mass, and suddenly dropping down, presses it into the meatpipe.—If in this process there is any want of consent, or co-operation of the parts,—if the food or drink is accidentally thrown into the pharynx, without the determinate action of the WILL, or if the WILL attempts to arrest the action of swallowing when the food has passed a little too far to be recovered, or if there happens to be a spasm or paralysis of any of the parts at the moment, a derangement of the function takes place, and a portion of the food or drink, passes into the exceedingly sensitive mouth of the windpipe, (§ 247.) which instantly gives alarm to its presiding centre, (§ 219.) and a convulsive expulsion of air from the lungs, drives the intruding substance violently back, through the mouth and nose, and in some instances, through the ears. But the irritation produced in the mouth of the windpipe, does not immediately cease when the irritating substance is expelled, and hence an unpleasant sensation and perhaps violent coughing continues for some seconds, or even minutes, after the expulsion takes place.

§ 428. As soon as the œsophagus receives the food, its muscular coat (§ 338. 347.) contracts upon it from above downward, and presses it onward into the stomach:—and at the same time, the mucous follicles (§ 333.) situated in this narrow passage, pour out their lubricating fluid, to shield the nerves and vessels of the lining membrane, (§ 287.) and to facilitate the movement of the descending mass. The œsophagus does not cease to act however, when the food has passed from it into the stomach; but continues,—and especially its lower portion, to contract vigorously from above downward to the cardiac orifice (§ 341.) to prevent a regurgitation of the food, during the action of the stomach.

Gastric Digestion.

§ 429. When the food reaches the stomach, it is instantly perceived by the delicate little *feelers*, (230. 237. 290.) which largely abound in the vasculo-nervous web of the mucous membrane, lining the gastric cavity, and these, at once, inform the presiding centre, (§ 220.) which throws its stimulus on the several tissues of the organ; (§ 313.) the muscular fibres (§ 347.) are called into rapid and vigorous action;—an increased quantity of arterial blood, is injected into the vessels, (§ 393.)—the nervous power (§ 164.) is exalted, and the temperature is somewhat elevated. By the contraction of the different layers of muscular fibres, the whole stomach is thrown into a gentle commotion, by which the food is carried around the gastric cavity, and everywhere pressed against the internal surface. This excites the little vessels, or as some say, glands (§ 332.) that secrete a thin transparent fluid, which very soon begins, like sensible perspiration, to exude from the mucous membrane, in small drops, and mingle with the food. This fluid is called the *gastric juice*, from *gaster* the ancient Greek name of the stomach. After the first portion of food has been carried about the gastric cavity, and freely mixed with this fluid, if the stomach be not crowded and embarrassed, by a too rapid ingestion or swallowing, its muscles relax in some degree, and the organ is prepared for another portion, which, when received, undergoes the same process as the first. These operations are continued, till the stomach is distended with food, and the meal is finished; when the muscular action becomes less rapid, and a gentle, undulating, or vermicular motion succeeds, and is kept up, till the func-

tion of the stomach is completed, and its contents are emptied into the small intestine.

§ 430. The process of digestion was formerly supposed not to commence, till some time after the food is received into the stomach: but this notion is now known to be incorrect. When the functions of the oral cavity are thoroughly performed, the process commences there. (§ 426.) The passage of the food from the mouth to the stomach, is too rapid to admit of any assimilating change, during the transition. But no sooner is the properly masticated food introduced into the stomach, than the process of gastric digestion commences.

§ 431. Concerning the nature of this process, and the means by which it is effected, the human mind has been busy with its speculations, from the time of Hippocrates, to the present; and perhaps, from a much earlier period: and, until a comparatively recent date, the results were little more than fanciful, and erroneous theories. Some supposed it to be a process of putrification,—others, a process of concoction,—others, of fermentation, and others, of trituration. Indeed, a century has scarcely elapsed, since any thing like a correct notion began to be entertained on the subject:—and even yet, there is no little discrepancy of opinion in relation to it, among physiologists. Dr. Beaumont of the United States Army, from his peculiar advantages, and by his patient perseverance in experiments and observations, has perhaps, done more than any other man, to settle the disputed points; but even he has evidently been misled in some respects by false theories, and has left broad ground for controversy.*

* Dr. Beaumont published in the close of the year 1833 his "Experiments and Observations on the Gastric Juice and the Physiology of Digestion." These experiments "were commenced in 1825, and continued, with various interruptions, till 1833." The subject of them

It is however, well ascertained that, the gastric juice is the principal agent, under vital control, of the change which the food undergoes in the stomach. This fluid, as well as that secreted by the salivary glands, and the pancreas, has frequently been analyzed by the chemists; but without the most remote advantage to physiology or medicine. As a matter of chemical science, we know what substances are obtained by a chemical analysis of the fluid taken from the stomach: but not the least ray of light is thereby thrown upon the physiology of the stomach. We know no better than we did before it was analyzed, what are the peculiar properties of this fluid, in the living stomach, by which it produces its specific effects, as an agent, in the vital process of digestion: and should we attempt to assist the stomach, by throwing into it, any of those substances which result from a chemical analysis of the gastric juice, we should be more likely to injure, than to benefit the organ. Indeed, it is well known that, both the chemical, and physiological character of the gastric juice, are very considerably affected by the dietetic habits, by the general state of the health, by the

was Alexis St. Martin, a Canadian of French descent, who, in 1822, when about eighteen years of age, with a good constitution, and robust health, was accidentally wounded by the discharge of a musket, the contents of which were received in his left side, and carried away the parts, so as to wound the lungs and stomach, very seriously. Under the care of Dr. Beaumont, St. Martin recovered his health; but in the healing of the parts, the lacerated coats of the stomach, attached themselves to the lips of the external wound, and formed an artificial aperture to the stomach; so that, the gastric cavity could be examined, and substances put into, or taken from it at any time, by pushing in a valve which the stomach had formed to close the aperture, so as to prevent its contents from escaping thereat. Dr. Beaumont's advantages for gastric experiments and observations were therefore, probably better than have ever been enjoyed by any other man, and they were diligently and faithfully improved.

affections of the mind, and by the conditions of the stomach: and this is also true of the salivary and pancreatic fluids; and in fact of all the fluids of the body. All physiological, and medical, and dietetic theories, and practices, therefore, founded on chemical knowledge, in regard to the secretions and assimilating changes, which are produced by the organic economy, are established in utter darkness, and are more frequently the sources of evil, than of good to mankind.

§ 432. We are told, it is true, that the gastric juice can be taken from the living stomach, and put upon cooked, and masticated food, in a glass vessel, and that, if it be kept at the temperature of the stomach, (§ 434.) it will, in the course of several hours, digest the food: and some of the chemical physiologists assert that, they can prepare an artificial gastric juice, which will do the same. And without doubt, they can prepare an artificial gastric juice, which will digest the food as well, as will the fluid taken from the stomach. But the truth is that, neither the artificial, nor real gastric juice can effect the changes, in an inorganic vase, which are produced in the living stomach. They may *macerate* or dissolve the substances on which they act, and reduce them to the *consistency* and *appearance* of the digested contents of the stomach, but they cannot produce genuine chyme, from which the appropriate organs of the living body, can elaborate chyle.

§ 433. The gastric fluid, therefore, is, in truth, a vital solvent: for, although it undoubtedly possesses in some degree, from its intrinsic character, a solvent and an antiseptic power,—especially if it be kept at a high temperature, yet it is only when acting under the vital control of the living organ, that it can be, in any measure, the agent of that vital change which is essential to genuine

chymification: and even in the living stomach, when the process of digestion is healthfully going on, if by any means, the nervous power of that organ, be considerably diminished, (§ 164.) the process will be retarded, and perhaps wholly arrested; and inorganic affinities will become active, and inorganic combinations result, in direct hostility to the vital welfare. For, not only disintegration and decomposition, but new and peculiar combinations take place in the vital changes, which are effected by the digestive organs; and these combinations as we have seen (§ 117.) are the results of affinities or forces, which act in opposition to the inorganic affinities of matter: and the inorganic affinities are subdued and the vital affinities superinduced, only by the immediate and controlling influence of the living organ. (§ 121.)

§ 434. During the early stages of gastric digestion, the pyloric orifice of the stomach, (§ 341.) is completely closed, by the contraction of the muscular fibres of the pylorus, (§ 347.) so that, the contents of the gastric cavity, cannot be pressed into the small intestine, by the muscular action of the stomach: and the alimentary mass is kept in constant motion; and becomes thoroughly permeated by the gastric juice. The temperature of the stomach is somewhat elevated by the concentration of vital power, in the tissues of the organ, to enable it to perform its function. In a healthy and vigorous body, it varies from a hundred, to a hundred and four degrees, *Fah.* When the digestive organs have been impaired, and chronic debility and preternatural irritability, induced in them, this concentration of vital energy, during the process of digestion, is often attended with a disagreeable feeling of chilliness of the external surface of the body, and many of the symptoms of an internal fever:—and more especially, if the dietetic habits are objectionable.

435. By the solvent power of the gastric juice, the food is gradually reduced to a soft pultaceous mass, and brought into a proximate state of chymification. The portions of the mass, which come in contact with the mucous membrane of the stomach, are then, still further acted on, by the vital powers of the organ, and, in a peculiar and inexplicable manner, the nutritious properties of the aliment, are converted into a substance, very different from any thing in the food, when it was received into the stomach. This substance is real chyme; and in the language of physiology, it is said to be homogeneous:—and, so far as chemical tests can determine, it is nearly identical in character, whatever be the kind, or kinds of food, from which it is formed. But in regard to its physiological qualities, and its nice relations to the vital economy, its character varies with the food, as we shall see hereafter. (§ 466.)

§ 436. When the portion of aliment, which comes in contact with the mucous membrane of the stomach, is converted into chyme, it is carried forward, by the muscular action of the stomach, slowly, towards the small extremity, and, as it advances, the chymifying change is more and more perfected, till it reaches the pylorus, or gate-keeper, (§ 347.) which, by a nice organic instinct, perceives its character and condition, and immediately opens, and suffers it to pass into the portion of the small intestine, called the duodenum. (§ 338.) When the pylorus is in a perfectly healthy state, if a crude mass of undigested food, attempts to pass into the duodenum with the chyme, it instantly closes, and the intruder is carried back, to be subjected still further, to the operations of the stomach. If it be of an indigestible nature, it is finally, either permitted to pass into the intestinal tube, or is suddenly and convulsively ejected from the stomach,

through the meatpipe and mouth. But when the stomach is greatly debilitated, and its organic sensibilities become unhealthy, (§ 296.) the integrity of the pylorus is impaired, and crude substances are frequently permitted to pass into the intestines, where they become the causes of irritation, and produce many uncomfortable disturbances, and in some instances, fatal disorders.

§ 437. When one portion of the contents of the gastric cavity, is chymified, and removed into the duodenum, another portion comes in contact with the inner surface of the stomach, and is operated on in the same manner, till the whole mass is chymified, and carried into the small intestine. But if, by a paralysis of the muscles of the stomach, or any other means, the chymified portion, in contact with the inner surface of the organ, is not removed, the process of chymification is entirely arrested. It is therefore, essential to genuine chymification, that, every portion of the alimentary matter, should come in contact with the living organ; and, in order to this, each successive portion, as it is chymified, must be removed: and hence, muscular action, though not immediately concerned in the vital change which takes place in the portion of the food in contact with the mucous membrane, is nevertheless, as essential to the general function of the stomach, as nervous power.

§ 438. Not only the unlearned reader, but even physiologists themselves are often betrayed into error, by the indefiniteness of the language used in physiological works. When it is said that, the alimentary matter received into the stomach, is, by the process of digestion, converted into a *homogeneous* substance called chyme, it should be understood, that, this is a general statement, which, in fact, is not strictly true. All the alimentary substances in nature, suitable for human food, consist of

certain proportions of nutritious and innutritious matter, and the alimentary organs of man, are constituted to receive, and act upon such substances. In the process of digestion therefore, it is only the nutritious portion, of the alimentary matter on which we subsist, that undergoes the assimilating change, and is converted into real chyme. The innutritious portion is simply separated from the nutritious, and reduced to such a state and condition, as fit it to pass along the alimentary tube, as fecal, or excrementitious matter. Nor is it strictly true, that, all the nutritious properties of our food, are perfectly chymified in the stomach, as is generally supposed. This error has grown out of the notion that, the stomach is peculiarly and exclusively, the organ of chymification: but this process, as we have seen, (§ 320.) is common to the whole alimentary cavity. The stomach receives the food from the mouth, more or less changed, according as the functions of the oral cavity have been more or less perfectly performed. (§ 426.) In the gastric cavity, a general solution of the alimentary matter, is effected, and, in the nutritious portion, the assimilating change is very far advanced; and, in some parts of it, the process of chymification is perfected, and the matter is prepared for the action of the organs which elaborate the chyle: and undoubtedly, this matter is acted on to some extent by those organs, before it leaves the stomach. (§ 388.) In other portions of the nutritious matter the chymifying change is not perfected in the gastric cavity, and therefore the process remains to be completed in other sections of the alimentary canal.

§ 439. Some kinds of food pass through the stomach much more slowly than other kinds: and the stomach of one individual, differs from that of another, in regard to the time employed in the process of digestion: and even

the same stomach varies in this respect, very considerably, with the varying circumstances and conditions of the individual:—but as a general statement, the food received at an ordinary meal, undergoes the process of gastric digestion, and passes from the stomach into the duodenum, in, from two to five hours.

§ 450.* When water is received into the stomach, it does not appear to undergo any change in the gastric cavity, but is all removed by absorption, in a very few minutes, if the stomach is healthy and vigorous; and still more rapidly, in some forms of disease, when the mucous membrane of the stomach (§ 338.) is inflamed, and the system is laboring under general symptoms of fever, attended with great thirst. In chronic diseases, of a dyspeptic character, on the other hand, absorption often takes place very slowly, and the water which is drank, will sometimes remain in the gastric cavity for hours, retarding digestion, and causing acidity, flatulence and eructations: and finally, perhaps, the greater part of it will be regurgitated or thrown up, with portions of undigested food. When liquid food, or water holding in solution any kind of nutritious animal or vegetable matter, such as flesh or vegetable broth or soup, is taken into the stomach, the aqueous part is all absorbed, before the process of digestion commences. Milk, also is managed in a similar manner. The gastric juice separates the curd from the aqueous portion, and the latter is absorbed, and the curd is then digested. But when indigestible substances are received into the stomach in aqueous solution, they are absorbed with the water and pass into the vital domain with no apparent change.

* There is an error in the numbering here, which was discovered too late to be corrected; but there is no interruption in the matter of the text; nor any disarrangement of the references.

Absorption.

§ 451. In what manner, and by what particular agents this absorption of unchanged matter is effected, are questions about which there has been a vast amount of controversy: to settle which, very numerous and diversified experiments have been made, on living animals and dead substances, and with very different and inconclusive results. —We have seen that, the skin and mucous membrane constitute the great enveloping and limiting membrane of the vital domain (§ 288. 330.) through which every thing passes that enters into, or egresses from that domain; and that, there is, on every part of the exterior surface of this limiting membrane, a vasculo-nervous web or plexus formed by the minute extremities of arteries, veins, lymphatics and nerves. (§ 287.) Of these three kinds of vessels entering into this web, the veins appear to be much the most numerous; and especially in the alimentary canal; where according to Dr. Horner, who is probably correct, the venous capillaries of themselves, form a superficial plexus. (§ 380. Note.) Now the grand question is, whether the lymphatics absorb both assimilated and unassimilated substances? or whether they absorb only assimilated, and the veins only unassimilated substances? Some physiologists have embraced one of these views, and some the other: and both have perhaps, been equally confirmed by experiments on living animals. These experiments however, have been wholly inconclusive; and from the nature of things, they ever must be. The actions of any part of the living body under the anguish and agonies of such experiments cannot afford conclusive evidence of the normal and regular functions of those parts. (§ 216.) Undoubtedly, under such circumstances, both the venous capillaries and the lymphat-

ics can be made to absorb foreign and unassimilated substances; and the fact settles no principle in physiology. The question is not, what are the abnormal possibilities of the organic system? but what are the regular, and appropriate functions of the parts in the normal condition and operations of the vital economy?—Here there seems to be less ground for dispute:—for there is little reason to doubt that, in the regular and undisturbed performance of their appropriate functions, the lymphatics, including the lacteals, (§ 387.) are principally confined to assimilated, and assimilable substances;—and foreign and unassimilated substances are mostly, absorbed by the venous capillaries. It is however, probable that, in some instances, foreign substances find their way into the lymphatic extremities which inosculate with the venous capillaries, and which transfer those substances to the veins in the lymphatic glands, in the portal system and at other points of connexion. (§ 386.)

§ 452. The venous capillaries then, which form the superficial venous plexus, of the mucous membrane of the stomach and intestines, (§ 380.) are undoubtedly the vessels which absorb the water and other substances that pass unchanged, from the alimentary cavity, into the vital domain: and these capillaries, we know to be the radicles of the great venous trunk of the portal system (§ 381.) through which, as a general fact, all unassimilated substances that enter the general circulation, find their way to the vena cava. (§ 378.)

§ 453. The pyloric orifice of the stomach, being nearly on a level with the cardiac orifice (§ 341.) or that at which the food enters, (fig. 26. *c b*) the contents of the gastric cavity, do not descend into the intestines by the force of gravity, but are, as it were, lifted up and pressed through the pyloric, orifice, by the contraction of the

muscular fibres of the stomach: (§ 347.) But there is comparatively, little of this action, when pure water is received into the gastric cavity, and consequently, very little of this fluid ordinarily passes into the small intestine, but is mostly taken up by the absorbents of the stomach. When irritating and deleterious substances are mingled with the water however, the absorbents of the stomach, receive it much more reluctantly; and, as the stomach will not long retain it, a considerable portion of it is expelled from the gastric cavity, into the small intestine. Hence when ardent spirit is introduced into the stomach of animals, and they are shortly after killed and examined, the mucous membrane, not only of the stomach, but also of the small intestine, is always found highly inflamed.

§ 454. The healthfulness and integrity of the digestive function of the stomach, then, depend principally, on three things.—1. Healthy and vigorous nervous power; (§ 164.) 2. healthy secretion; (§ 429.) and 3. healthy and vigorous muscular action: (§ 347.) and neither of these, can be impaired without injuring the others. The nervous power always suffers from all inordinate mental action and excitement, and especially from the depressing passions such as fear, grief, painful anxiety, &c. (§ 304.) Narcotic substances of every kind, and in fact, all purely stimulating substances, also impair the nervous power.—Improper kinds and conditions of food, gluttony, lewdness, sensuality of every kind, in short, every thing that tends to impair the general health of the body, serves to diminish the nervous power of the stomach: and all these causes injuriously effect the secretions, and the muscular power and action of that organ; and consequently, impair the healthfulness and integrity of its function.

Chylification.

§ 455. As the chyme passes from the gastric cavity into the duodenum, or upper portion of the small intestine, (§ 338.) it is instantly perceived by the innumerable little feelers or nerves of organic sensibility, in the vasculo-nervous plexus of the mucous membrane, (§ 287. 290.) and they, like those of the stomach, (§ 429.) immediately inform their presiding centre or centres, (§ 220.) by which the muscles of the part are excited to action, causing a vermicular, or worm-like motion by the successive contraction of the fibres (§ 347.) from above downwards. By this motion the chyme is slowly carried along the intestinal tube; its course being considerably retarded by the semilunar folds of the mucous membrane, (§ 246. Fig. 32.) and at the same time, a solvent fluid nearly resembling the gastric juice, exudes from the vessels of the membrane. (§ 239.)

§ 456. As soon as the chyme enters the small intestine, the lacteals which, as we have seen, (§ 388.) very numerous abound in this section of the alimentary canal, begin to act on the most perfectly assimilated portion of it, and to elaborate from it, their peculiar fluid called the chyle. (§ 153.) And, as the chyme moves slowly along the living tube, presenting its most perfectly assimilated portions to the lacteals of the successive parts, the digestive or chymifying process is at the same time, carried on by the vital energies and secretions of the tube: so that, while the lacteals in one part of the intestine, are acting on the most perfectly assimilated portion of the chyme, the less perfectly assimilated portions are preparing for the lacteals of the succeeding part. In this manner, the two assimilating processes are carried on through the

whole length of the small intestine, or until all or nearly all of the nutritious matter of the food, is converted into chyme and chyle. Some physiologists suppose these processes are continued in the large intestine, and that the cæcum (§ 346.) acts as a kind of second stomach, to complete the digestion of the nutritious matter, which may be received from the small intestine: and it is undoubtedly true that, nutrition may, to some extent, be effected through the large intestine: (§ 388.) and that, when nutritious matter reaches this section of the alimentary canal both chymification and chyfication to some extent, take place in it. The principal office of the large intestine however, is to receive, and dispose of the fecal or excrementitious matter of the food. But whether the process of chymification is ordinarily, continued into the large intestine or not, it is very certain that, the most perfect performance of the functions of the small intestine, including both chymification and chyfication, requires that, the stomach should not be employed at the same time: and hence, the reception of food or other substances, into the gastric cavity at improper times, and in fact, all dietetic irregularities, always, in some measure, disturb the functions of the small intestine.

§ 457. It has generally been supposed that, the chyle is formed in the small intestine, by the mixture of the pancreatic juice and bile with the chyme, and that it is merely absorbed or sucked up, and conveyed to the thoracic duct by the lacteals. (§ 388.) This notion however, is entirely erroneous, and will probably, soon become obsolete. There is not a particle of chyle formed in the alimentary cavity. The only assimilating change effected in that cavity, is, as we have seen, (§ 320.) that of chymification; and therefore, all the secretions, both of

the alimentary canal and of its glandular appendages (§ 343.) which are in any manner immediately concerned in the great process of assimilation, are employed in the production of chyme. The pancreas, (§ 342.) in structure and appearance, is almost precisely like the salivary glands, and there is no essential difference between the pure salivary, gastric, and pancreatic fluids,—the different degrees of acid and other qualities found in one or the other of these fluids, being wholly accidental; and owing to the physiological condition of the system, or to the peculiar state of particular organs. The pancreatic fluid therefore, is employed in perfecting the process of chymification, in the small intestine; and accordingly, the pancreas, as well as the salivary glands, is proportionably largest in those animals which subsist on food that requires the greatest quantity of solvent fluid for its chymification.

§ 458. In order to a clear and correct understanding of the use of the bile, in the economy of the alimentary cavity, it is necessary that we should take a comprehensive survey of most of the parts contained in the abdomen.

1. The alimentary canal presents a surface of about thirteen square feet of mucous membrane: and this surface is everywhere covered by a close plexus of minute vessels and nerves which are employed in the performance of greatly diversified, and most important functions; (§ 331.) and of these vessels, the venous capillaries are by far the most numerous. 2. All the venous capillaries of this extended surface, together with those of the spleen, (§ 381.) of the pancreas, of the mesenteric glands, &c. (§ 386.) run into veins, which unite to form the great venous trunk of the portal system. (§ 381.) 3. The portal trunk, instead of proceeding to the heart or vena cava, (§ 378.) plunges into the liver, (§ 335. 341.) where it is ramified in precisely the manner of an artery, and

holds the same relation to the biliary ducts, that the artery does to the excretory ducts of other glands, (§ 324.) and forms by far the greatest part of the vascular substance of the organ: while the hepatic artery is evidently, designed for the nourishment of the tissues of the liver; for it is distributed on other vessels, giving rise there, to a very complex net-work. The finest ramifications however, enter the vena porta; and the hepatic veins, the twigs of which are fewer and larger than those of the vena porta, and the hepatic artery, receive their blood, not from the artery, but from the vena porta. 4. According to the general law of the organic economy, (§ 393.) that as the degree of vital action in a part, so is the supply of arterial blood to that part,—a great quantity of arterial blood is sent to the stomach and intestines, during the performance of their general function of digestion; and a large proportion of the volume of this blood, remaining after the tissues of the organs are nourished and their vital powers replenished, (§ 376.) and the secretions, exhalations, &c. are accomplished, is, by these processes, converted into venous blood, and must be returned to the heart and lungs for renovation. 5. Not only the water, which is received into the stomach as drink, but the aqueous portions of the food, and many other substances,—some of which, if permitted to pass into the general circulation, would prove exceedingly deleterious to the system,—are absorbed, unchanged, and mingled with the venous blood just spoken of; and hence, this blood, so freighted with impurities, instead of being permitted to return to the heart and lungs in the ordinary manner of the venous blood from the other parts of the body, is furnished with the peculiar apparatus of vessels which constitute the portal system, (§ 381.) and by which it is poured into the largest gland, and almost the largest

organ of the whole body; and thus, all the venous blood from the tissues of the alimentary canal, with all its foreign substances and impurities, is filtered through the liver, before it reaches the heart, and returns to the pulmonary, and general circulation: and it is entirely certain that, the liver in its normal state, and in the regular performance of its function, secretes the bile from the blood thus furnished by the portal veins; and not from the arterial blood;—the latter being necessary only to nourish the tissues of the organ, and sustain their functional powers, and supply the biliary ducts with mucus:—yet after having done all this, and become venous blood, it enters with the portal blood, into the venous plexus where the bile is secreted; and therefore, in the absence of supplies from the vena porta, bile can be secreted, to some extent, from the blood which enters the liver in the hepatic artery. Again, we know that, when foreign substances are absorbed from the alimentary canal, if, by any means, they can be detected in the blood, they are readily found in the spleen, in the portal veins, and in the liver; even when no trace of them appears in the thoracic duct, (§ 386.) nor in the general circulation. Indeed it is nearly certain that, in the general health and perfect integrity of the system, there is a way, by the intercommunication of veins and lymphatics, (§ 386.) through which foreign and unassimilated substances, absorbed from the alimentary cavity, are carried off to the kidneys, lungs, skin, and other organs, and expelled from the vital domain, without being permitted to enter into the general circulation. But when deleterious substances are habitually received into the alimentary cavity, and taken up by the absorbents, the nicely discriminating organic sensibility of the organs, (§ 296.) is gradually depraved, and their functional integrity impaired, till they finally, suffer those substances to

pass freely into the general circulation, and throughout the whole system. And hence, it is that when ardent spirit is only occasionally drunk, it can very rarely, if ever, be detected in the general circulation; even while it is strongly exhaled from the lungs: but when an individual becomes an habitual drunkard, and continues his inebriation for several days in succession, the blood taken from the vein of the arm, is found strongly charged with alcohol.

§ 459. Still further, in regard to the liver and its secretion; it is now well ascertained that the bile is not, in any manner, directly concerned in the formation of chyle, nor is it indirectly subservient to that end, any further than it may assist in the process of solution, preparatory to chymification: for both chyme and chyle are regularly produced without any agency of the bile. (§ 388.)

Moreover, it is well known that the liver is largely developed, and performs its secretory function, to some extent, before chymification and chylification take place in the system. Besides, if the liver had been designed to secrete a fluid essential to the assimilating processes of the alimentary cavity, and primarily intended for that use, it would be furnished with no sac or reservoir to receive and retain its secretion; but would, like the salivary glands, secrete its fluid only when the wants of the vital economy required it, and pour it directly into the cavity, where it was needed. But the secretion of the liver is continually going on; and, because the bile cannot be continually poured into the alimentary cavity, consistently with the general and particular regulations of the vital economy, the liver is furnished with a reservoir, (§ 341.) which receives its secretion, and retains it until an opportunity is afforded for its discharge into the alimentary cavity.

§ 460. Now then, in view of all these facts, is it not

fully evident, that the liver is a great filtering gland, designed to separate the impurities from the venous blood of the portal system, coming from the tissues of the alimentary canal? But we have seen that, there is a large quantity of this blood, and that the whole of it must filtrate, as it were, through the liver (§ 458.) before it reaches the heart: and furthermore, the quantity of blood in the portal system is not always the same. The arterial supply to the alimentary organs, being greatly increased during their performance of the function of digestion, (§ 393.) there is consequently and somewhat suddenly, a commensurate increase of the quantity of venous blood returning from those organs. At the same time, also, considerable quantities of aqueous fluid, are, or may be absorbed from the alimentary cavity, (§ 450.) and mingled with this blood in the portal veins, greatly and suddenly increasing its volume. It follows therefore, of necessity, either that, this heterogeneous fluid is, at times, driven through the liver with excessive rapidity, or that, the veins of the portal system, are at times, suddenly and excessively distended, or that, there is connected with the portal system, a vascular appendage, which serves as a reservoir, to receive a portion of this fluid, when its volume is increased, and retain it till the liver, in the regular performance of its function, is prepared to act upon it. Precisely such a vascular appendage is found in the SPLEEN. (§ 382.) The structure of that organ, its connexion with the portal system, the regular increase of its volume with the increase of venous blood returning from the tissues of the alimentary canal, its somewhat sudden enlargement when fluids are absorbed from the stomach, and the fact that, foreign substances absorbed from the stomach, are invariably to be found in its blood, if they are such as can be detected at all within

the vital domain, and the fact also, that it can be extirpated from the body without destroying life and apparently without detriment to health,—all concur to prove, most conclusively, that the spleen is nothing more nor less than such an appendage or reservoir to the portal system. And the whole organization, arrangement, and economy of the parts, clearly prove that, the portal system, the spleen, and the liver, constitute an apparatus of organs, designed to receive the venous blood from the tissues of the alimentary canal, mingled with whatever foreign substances may be absorbed from the alimentary cavity, and so far to purify that blood, as to prepare it to return to the heart and lungs, with safety to the vital domain. And this purification evidently does not consist exclusively in the secretion of bile; but it is nearly certain that this apparatus has a vascular communication with the kidneys and lungs, and perhaps also with other organs through which it disposes of foreign and unassimilated substances without suffering them to pass into the general circulation. (§ 458.)

§ 461. The grand function of the liver, in the vital economy of the general system, therefore, is evidently that of a depurating or cleansing organ; and consequently, the bile is *primarily*, an excrementitious substance, thrown into the alimentary cavity, to be carried off with the fecal matter of the food; and hence, as a normal fact, it enters freely into the small intestine, only when that tube is distended with alimentary matter, and then, always mixes most intimately with the fecal portions of that matter. It is nevertheless true, however, that, though the bile is secreted for the primary purpose of purifying the blood, and is therefore an excrementitious substance, yet by a wise provision, it is in some respects, made subservient to the chymifying or digestive process of the alimentary

cavity.—How far our benevolent Creator prospectively adapted the range of capabilities in this portion of the organic economy, to the artificial and depraved habits of man, it is impossible to say; but it is certain that, those habits do extensively call into requisition the biliary secretion for purposes which are by no means compatible with the best interests of the body.

§ 462. Not only the animal, but nearly all the vegetable substances on which man subsists, contain more or less of fatty or oily matter: and it is now fully ascertained that, when this matter is introduced into the alimentary canal, the gastric juice has little or no effect on it, until it is in some measure changed by other means. When only the lean part of flesh-meat, or such vegetable substances as are best adapted to the alimentary wants of man, are received into the human stomach, the oily matter is in so small a proportion, and so diffused in particles through the general mass, that the food is sufficiently digested in the gastric cavity, to afford portions of perfect chyme for the action of the lacteals, and to fit it to enter the duodenum, with little or no change in the oily matter. Soon after it is received into this section of the alimentary canal, the bile is mixed with it, (§ 341.) and acts on the oily matter as an alkali, and converts into a saponaceous substance, which is immediately acted on by the solvent fluid from the pancreas (§ 457.) and other chymifying agents of the small intestine, (§ 455.) and with difficulty, converted into chyme. But when a considerable proportion of the food consists of animal or vegetable fat or oil, it cannot be so far chymified in the stomach, by the secretions and actions of that organ, as to fit it to enter the small intestine safely, and without disturbance. In this emergency, the stomach is irritated by the presence of the unmanageable substance, and the

biliary apparatus sympathizing (§ 297. 341.) with the stomach, in its irritations, pours the bile freely into the duodenum, where, instead of descending in the usual manner along the alimentary canal, (§ 341.) it is carried up, and admitted through the pyloric orifice, into the gastric cavity, to assist the stomach in the digestion of its contents, by converting the oily matter into a kind of soap, and thus rendering it soluble by the gastric juice. But the introduction of the bile into the stomach, though rendered necessary by such exigencies, is nevertheless, utterly incompatible with the best physiological condition, and most perfect functional integrity of that organ.

§ 463. Besides the oily matter of our aliment, there is frequently more acid in some kinds of food than is consistent with the welfare of the intestines; and this acid is, in some measure, neutralized by the alkaline properties of the bile, soon after the chyme enters the duodenum.

§ 464. To act as an alkali on the oily matter and the acids of the alimentary contents of the intestines, is therefore, the *secondary*, and often very important use of the bile; and in no other respect nor manner, is it concerned in the production of chyle.

§ 465. The chyle, I have said, (§ 457.) has generally been supposed to be formed in the small intestine, and to be merely sucked up by the lacteals; and hence, in all works on physiology, these vessels are said to *absorb* the chyle. But as there is not a particle of chyle formed in the alimentary cavity, the function of the lacteals is rather that of *secretion* than of absorption: for, instead of simply sucking up a substance already formed, they elaborate, as it were, an entirely new substance from the most perfectly chymified portions of the food: and in this process, it is evident that there is a further decomposi-

tion of the chymified matter, and new combinations and arrangements of its particles, so that, the chyle possesses a different constitutional nature from the chyme, and is essentially a different substance. (§ 140.) Indeed, this is a vital function of a mysterious and most wonderful character, which has completely foiled the ingenuity and beggared the calculations of the chemical physiologists; who, taking the results of the chemical analysis of dead animal matter for their data, (§ 147.) have endeavored to reason out the elementary laws of vital action, and organic combination.—In vain have they attempted to regulate the diet of man on chemical principles, (§ 151.) and insisted on the necessity for certain chemical properties in human aliment, to sustain the vital economy. That economy has shown them that, it can triumph over the chemical affinities and ordinary laws of inorganic matter, and bend them to its purposes at pleasure;—generating, and transmuting from one form to another, with utmost ease, the substances which human science calls elements; (§ 51.) and while the living organs retain their functional power and integrity, elaborating from every kind of aliment on which an animal can subsist, a chyle so nearly identical in its *physical* and *chemical* character, that the most accurate analytical chemists can scarcely detect the least appreciable difference.*

§ 466. The lacteals seem to possess the transmuting

*The scientific world has been greatly misled on this subject by the inaccuracies of the chemists. We have been told by some, that chyle formed from vegetable food contains much more carbon and less nitrogen than that formed from animal food: but it is now ascertained that all such statements are incorrect; and that if there be perfect health and functional integrity of the assimilating organs and of the system generally, the chyle formed from vegetable, and that from animal matter, are so nearly identical in chemical composition that no appreciable difference can be detected by the most careful and accurate analysis.

power of vitality in an eminent degree. The chyle which is found nearest to their secreting radicals or mouths, is of an entirely different nature from the chyme in the alimentary cavity. (§ 153.) It is a thin aqueous fluid, of a milky or pearly appearance, and is slightly albuminous; and when examined under the microscope, is found to contain the globules (§ 157.) peculiar to animalized matter, and which are supposed to be the elementary nuclei of all the solid forms of matter in the living body. The color of this fluid varies somewhat, with the quality of the aliment;—being always more white in proportion as fatty or oily matter abounds in the food.—As the chyle flows along the lacteals, and passes through the mesenteric glands, (§ 336.) (figs. 46. and 49. *d e*) it is more and more assimilated to the blood: and, before it mingles with this latter fluid, it is apparently like it, in all respects, excepting color. (§ 154.) The proportion of its fibrin, or more correctly speaking, of its globules, to its other properties, even in a carnivorous animal accustomed to a mixed diet, is so nearly the same, when the food is exclusively vegetable, and when exclusively animal, that the difference is scarcely appreciable. But the chyle elaborated from purely vegetable food differs in one respect, most remarkably, from that formed from purely animal food.—When taken from its living organs the chyle elaborated from animal food putrefies in three or four days at longest, while that, from the vegetable food, may be kept for several weeks without becoming putrid. This is an exceedingly important physiological fact, which does not seem to have been sufficiently appreciated by physiologists. (§ 924).

§ 467. In regard to the effect which the mesenteric glands have upon the chyle in its passage through them,

there has been some diversity of opinion, among physiologists; and yet, when the structure and office of these glands are contemplated in connexion with the general and particular economy of the system, there appears to be little ground of doubt concerning them. They are as we have seen (§ 386.) little more than intricate plexuses of minute vessels and nerves, having none of the peculiar characteristics of secreting organs, and are therefore more properly called vascular ganglions, than glands. The vessels of these ganglions consist mostly of lacteals or lymphatics; and with these are associated numerous veins, which arise from the ganglions, and which in the ganglions, communicate with the lacteals or lymphatics, by opening, the one into the other. It can hardly be doubted therefore, that these ganglions are formed for the sake of establishing such communications between the lacteals or lymphatics and the veins, as will enable the former to expel into the latter, such foreign, or other substances, as they may contain, which cannot safely, or consistently with the greatest good of the system, be permitted to pass into the thoracic duct. The chyle, in passing through these ganglions, therefore, is probably no further affected than to be in some measure purified, by the removal of the foreign substances or crudities which it may contain. This opinion appears to be supported, not only by the anatomical structure of these ganglions and the general physiological analogies of the vital economy, but also by all the physiological phenomena pertaining to them both in their healthy and in their morbid state.

§ 468. If the opinion of some anatomists, that, most or all the lacteals traverse a portion of the liver (§ 388.) before they reach the thoracic duct, be correct, it is probable that they do so for the purpose of still further

communicating with venous capillaries, into which, they may discharge any remaining crudities or unassimilated substances contained in the chyle.

§ 469. When the chyle reaches the thoracic duct, (§ 386.) into which it is conveyed by the lacteals, (fig. 49. *b f g*) it is in a very advanced state of assimilation to the blood; being possessed of a considerable share of intrinsic vitality, (§ 203.) and largely abounding in elementary animal molecules. (§ 466.) Before leaving the thoracic duct, each of these minute animalized molecules, becomes invested, or surrounded by a thin pellicle or tunic, and being thus invested they are prepared to enter into the great highway of the returning circulation, and after having undergone the process of the lungs, to become the globules of the blood. Sometimes also, the chyle is found to be slightly pink-colored before it leaves the thoracic duct. Being in all respects prepared for a passage to the lungs, in company with whatever impurities it may meet with in the venous blood, (§ 458.) the chyle is carried up by the thoracic duct, (fig. 48. *D D*) and emptied into the subclavian or large vein coming from the left arm at the point and in a manner which I have described. (§ 386.) Here it mingles with the venous blood with which it flows into the right auricle of the heart, (§ 368. 369.) and thence passes into the ventricle, by which it is sent through the pulmonary arteries (§ 359. 369.) into the capillaries of the lungs, where the grand process of digestion is completed, which commences in the mouth, (§ 426.) and continues all along the living, alimentary and lacteal canals and tubes, till the chyle is poured into the veins; and then no further change takes place till it reaches the lungs.

§ 470. The precise change which is effected in the chyle, while in the lungs, is not known; as it always goes

to the lungs mingled with a large quantity of venous blood. It appears pretty certain however, that the chyle which goes to the lungs nearly colorless, there becomes red, and is more perfectly animalized, and more highly endowed with vitality.—I say more highly endowed with vitality, because it is evident that, the chyle is in some measure, a vital fluid, before it reaches the blood-vessels. (§469.) As the chyle and venous blood however, are mingled together, and are operated upon by the lungs, at the same time, I shall embrace the two at once, in my descriptions of the physiology of respiration and circulation.

§ 471. The blood, which is diffused throughout the body by the heart and arteries, for the nourishment of the whole system, is not all taken up and appropriated in its first distribution; but a considerable proportion of it, is returned through the veins and large venous trunk, to the right auricle of the heart. (§368. 369.) In consequence, however, both of the absence of properties which have been abstracted by the arterial capillaries, in the general function of nutrition, and of the presence of other properties which have been accumulated in the course of the circulation, the venous blood returns to the heart, dark and full of impurities, and wholly unfitted, in its condition, to supply the wants of the system. Should it be forced, unchanged, into the general arterial circulation, the action of the circulating organs, would immediately become extremely feeble and interrupted,—nutrition would cease,—animal sensibility and consciousness would be instantaneously abolished,—all the functions of organic life would falter, and death would soon ensue. The venous blood therefore, must either be wholly thrown out of the system, as excrementitious matter, or it must, by some renovating, vital process of the organic

economy, be restored to its original character as arterial blood.—Should it be eliminated as excrementitious matter, the demand for alimentary supplies in the digestive organs, would be vastly increased. The benevolent Creator has therefore, established a special economy, by which the venous blood is purified and renovated, and perfectly restored to its original character; and fitted for supplying the wants of the system, equally as well as new-made blood:—and in doing this, He has, in a truly wonderful manner, combined vital function with physical and mechanical advantage and convenience.

§ 472. As soon as the returning blood of the veins, is poured from the large venous trunks (§ 378.) into the right auricle of the heart, the walls of that cavity contract upon it, and press it down into the right ventricle, (§ 369.) from which, the tricuspid valve prevents its returning. No sooner does it enter this ventricle than its walls also, contract upon it, and send it through the pulmonary artery and its branches, into the capillary vessels of the lungs, which are ramified upon the air-cells as I have described. (§ 359.) While passing through these minute vessels, the chyle and venous blood undergo those important changes by which they both become arterial blood. In regard to these changes, physiologists have indulged in extensive speculations, some of which are exceedingly ingenious and interesting. But it would not be a profitable employment of time to review them on this occasion; and therefore, I shall only present the conclusions to which I have arrived, after careful examination of the whole subject—merely observing, by the way, as a general remark, that with respect to respiration, as well as all the other vital functions of the body, many physiologists appear to

have erred by attempting to explain vital phenomena on the principles of inorganic chemistry.

Respiration or the Function of the Lungs.

§ 473. It is, doubtless, a matter of general knowledge, that, according to modern chemistry, the atmosphere is composed of several gases or kinds of air, and a considerable quantity of water in a state of vapor.—Pure air however, according to the statements of chemistry, consists of twenty parts of oxygen gas, and eighty parts of nitrogen or azote. (§ 99.) But by means of the chemical changes of composition and decomposition, which are continually going on in nature, various gases are evolved and become more or less diffused throughout the atmosphere:—some of which, are too subtil to be detected by the closest scrutiny of the chemist; and others are so volatile and light that, they ascend to the upper regions of the atmosphere, where they probably undergo new changes, and enter into new forms. Some however, enter into combinations near the earth's surface, and are of sufficient specific gravity, or weight to remain in the lower region of the atmosphere.—Of these, about one per cent. of carbonic acid gas, formed by a chemical combination of certain proportions of oxygen and carbon, is always, and universally present.

§ 474. The oxygen and azote of the atmosphere, are not chemically combined, as in nitric acid; but intimately mixed together;—so that, when a portion of the oxygen of a given volume of air, is consumed, the remaining oxygen diffuses itself equally, throughout the whole volume, as fast as the consumption takes place. This law of nature, established by a wise and benevolent Cre-

ator, is of immense importance to all living bodies; both animal and vegetable.

§ 475. Now, in regard to the changes which take place in the lungs, there are certain phenomena or facts, attending respiration, on which physiologists have built their theories of the function.—In the first place, the venous blood goes from the heart to the lungs, with a dark purple color, and unfitted for the purposes of nutrition in the system; and returns from the lungs to the heart, with a bright red color, and possessed of all the properties requisite for supplying the general wants of the vital economy.—In the next place, the air goes into the lungs composed of about seventy-nine or eighty parts of azote, nineteen or twenty parts of oxygen, and one per cent. of carbonic acid gas; and returns from the lungs, with about the same proportion of azote, five or six parts of oxygen, and thirteen or fourteen parts of carbonic acid gas.—In some way or other, therefore, the oxygen of the inspired air, suffers a great diminution of volume in the lungs, and a volume of carbonic acid gas is produced equal, or nearly equal to the loss of oxygen. These facts led the chemists to conclude that, the venous blood, and perhaps the chyle also, give off a quantity of carbon in the lungs, and that a part of the oxygen of the inspired air, combines with the carbon, and forms the carbonic acid gas. And as it is a law in inorganic chemistry, that when oxygen combines with carbon in the formation of carbonic acid gas, heat is always produced, a most ingenious and beautiful theory of animal heat, has been built upon this view of the function of the lungs.

§ 476. Mr. Crawford, who principally matured this theory, reasons thus:—When the venous blood gives off its carbon in the lungs, its capacity for caloric, or the substance of heat, is increased,—the carbon thus set free,

instantly combines with a portion of the oxygen of the inspired air, and forms carbonic acid gas, by the process of which combination, heat is evolved, and that heat is instantly taken up by the increased capacity of the, now, arterial blood; and as this blood is diffused into every part of the system, and becomes changed into venous blood again, its capacity for caloric is diminished and the heat is given off.

§ 477. This was making the changes effected on the blood and chyle in the lungs, and the production of animal heat, purely, processes of inorganic chemistry. And perhaps, never was an erroneous theory more ingeniously constructed or more plausibly supported. But it has been fully ascertained, by numerous experiments and extensive investigation, that the oxygen of the inspired air does not combine with the carbon of the blood in the lungs to form the carbonic acid gas of the expired air;—for this gas continues to be expired from the lungs, when nothing but pure hydrogen is inhaled:—neither does the oxygen enter, in a free state, into the blood, to combine with carbon and form carbonic acid gas, and evolve heat, in the course of the circulation, as some have suggested. The whole chemical theory therefore, in regard to respiration and the production of animal heat, is without the support of any well established facts requiring such an explanation; and it is certainly contrary to all correct notions of the vital operations, and the general physiological economy of the living body.

§ 478. The function of the lungs may be considered as twofold. As depurating or cleansing organs, they eliminate the impurities of the blood, in a manner corresponding with the functions of the external skin and the mucous membrane generally, (§ 289.) and with all the excretory organs of the body:—and as organs of nutri-

tion they digest the air and convert a portion of it into the substance of the blood.

§ 479. As depurating organs, the lungs, by a vital process, continually excrete from the venous blood, and perhaps also, from the chyle, in their capillary vessels, certain substances, the elimination of which, is necessary, to prepare those fluids for the nutrient purposes of the system.—As soon as the excreted substance or substances are thrown into the air-cells, (§ 353.) the matter composing them, yields to the affinities of inorganic chemistry, and issues from the lungs, in the form of vapor, of carbonic acid gas, &c.—The vapor thrown from the lungs in this manner, sometimes amounts to nearly a quart of water, in twenty-four hours.—A portion of this, is supposed to come from the chyle.—The quantity of carbonic acid gas discharged from the lungs, in the twenty-four hours, is also very considerable. This gas is unfit for animal respiration; and when inhaled into the lungs, without a mixture of atmospheric air, it soon causes suffocation, asphyxia and death. This effect however, is owing to its negative, rather than to its positive qualities; or to the absence of oxygen, by which alone, animal respiration is supported: for carbonic acid gas can be introduced freely into the stomach without having any of the effects of a poison upon the system. It is by the consumption of the oxygen of the air, and the generation of this gas, by the burning of charcoal in an open vessel in a tight room, that life is often destroyed:—and for the same reason, a large number of people in a close or ill ventilated room, by their continued respiration and perspiration, render the air very impure and unwholesome:—and were it not for a wise and benevolent arrangement in the general economy of nature, in regard to this gas, all animals would soon be

destroyed by it. (§ 143.) Being specifically heavier than atmospheric air, it sinks below the nostrils and mouth of the animal, during the little pause which follows expiration, and thus, is prevented from being drawn into the lungs again, in the succeeding act of inspiration. Descending towards the earth, it becomes diffused through the atmosphere, and during the day, it is taken up by the vegetable organs of nutrition, and decomposed,—the oxygen being set free and the carbon retained, and converted to vegetable substance. (§ 143.) During the night, or prevalence of darkness, however, plants, like animals, are said to give off carbonic acid gas. But it is supposed that their consumption of it during the day, is sufficient to preserve the atmosphere in a state proper for animal respiration.

§ 480. When the blood, in the capillary vessels of the lungs, is purified in the manner I have described, it is prepared to receive a portion of the digested and assimilated air. This is also, a purely vital process. The lungs are constantly receiving fresh supplies of aeriform aliment, which like the food received into the stomach, consists of certain adapted proportions of nutritious and innutritious substances : (§ 438.) and although expiration always, immediately follows inspiration, yet the lungs are never entirely exhausted; but, a considerable volume of air always remains in them,—much larger than that which is inhaled at an ordinary inspiration.* The air which we expire therefore, is probably very little, if any of it, that which was received by the immediately preceding inspiration.—But each successive volume of inspired air probably displaces an equal volume of the retained

* According to Menzies and Goodwill, five times the quantity of air remains in the lungs after ordinary expiration that is ordinarily expired or inspired, at any one time.

air, which has been acted on by the digestive powers of the lungs;—and thus, something like an aerial circulation, or the gradual process of digestion in the alimentary cavity, takes place in these organs.

§ 481. If the top of the intestinal tube in a dog, be tied, close to the pyloric orifice of the stomach, so that nothing can pass from the gastric cavity into the intestines, and a quantity of proper food, suitably masticated, be introduced into the stomach, that organ will convert the nutritious properties of the food into chyme, and its lacteal or lymphatic vessels will elaborate from that chyme, a quantity of chyle sufficient to answer the immediate demands of the vital economy, and the fecal parts of the food, together with some remaining chyme, will then be ejected or regurgitated from the stomach, through the meatpipe and mouth. In this manner, the animal may be sustained for six or eight weeks. (§ 388.) This, affords a good analogical illustration of the digestive function of the lungs.—Having but one orifice, they throw off their excrementitious matter through the same aperture by which they receive their aeriform food.

§ 482. Oxygen is undoubtedly, the nutrient property of the air, (§ 475.) and hence, it is said that it supports respiration :— (§ 92.) yet I contend that it never becomes incorporated with the blood *as oxygen*; (§ 112.) but it is digested or decomposed in the vital process by which it is converted into the substance of the blood, and becomes a constituent and identical part of it; and then it is not oxygen nor any thing else but blood. Nor is it, till the vitality of that fluid is destroyed, and its constitutional nature essentially changed; that oxygen or any other chemical element can be obtained from the perfectly healthy blood. The quantity of oxygen consumed by an individual is said to vary with the nature

and degree of exercise, state of mind, degree of health, kind of food, temperature of the atmosphere, &c. Much more is consumed when the weather is cold, than when it is warm—more during digestion than when the stomach is empty;—and less is consumed when the food is vegetable than when it is animal,—less when the body is at rest than when in action—and less when the mind is calm than when it is disturbed. The average quantity however, is supposed to be about two pounds and eight ounces, troy weight, per day.

§ 483. That some of those forms of matter which are called chemical elements, are largely employed in supplying the wants of the vital economy of the living body, and that some of them are better adapted to supply particular wants, or produce particular effects in that economy than others, is most evidently true; (139.) but this is far from proving that those forms pass unchanged through the vital processes into the vital results; and still less does it prove that the laws which govern those substances as chemical elements, in the processes of inorganic chemistry, go with them into the vital domain to control the action of their affinities, and the modes of their combination.

§ 484. In suffering this two-fold function of the lungs, the chyle and dark-purple venous blood, become converted into bright-red arterial blood, fitted to supply all the wants of the vital economy. And the more completely the function of the lungs is fulfilled, the more richly is the blood endowed with those delicate properties which gratefully exhilarate every part where the living current flows,—healthfully invigorating all the organs, and giving increased elasticity to all the springs of action in the system,—causing every function to be more perfectly performed,—imparting buoyancy to the animal

spirits, (§ 305.) and delightfully exciting and facilitating the intellectual operations.

Circulation, Quantity and Quality of the Blood.

§ 485. The blood thus purified and renovated in the lungs, returns in the pulmonary veins to the heart, (§ 359. 369.) and is emptied into the upper cavity or auricle on the left side. The walls of this cavity instantly contract, and press the blood into the lower cavity or ventricle on the same side, whence it is prevented from returning to the auricle, by the mitral valve (§ 369.) which is pressed up and closes the opening between the two cavities. No sooner does the blood enter the left ventricle, than the thick muscular walls of this cavity vigorously contract, and throw it into the aorta or great arterial trunk, (§ 369.) which being always full of blood, that which is thrown from the heart, presses on that which is in the arterial tube, and thus, by the constant action of the heart, the column of blood in the aorta is continually moved on, in the same manner that a column of water is raised in a common pump, till it flows through the arterial branches into all the capillary extremities, and is thus, with the assistance of arterial and capillary action, diffused over the whole body: (§ 374.)—imparting nourishment to the bones, cartilages, ligaments, tendons, membranes, muscles, and nerves, and supplying the various secretory organs with the blood from which they separate, or elaborate their lubricating and solvent and other fluids and substances. And, passing from the capillary extremities of the arteries to those of the veins, (§ 378.) the unappropriated blood, now rendered dark and impure, or unfitted for the purposes of nutrition, (§ 471.) is carried back to the heart and lungs, to be

purified and renovated, in the manner I have described, (§ 479. 480.) and then thrown again into the general circulation.

§ 486. The whole quantity of blood, in the body of an ordinary sized man, is from three to four gallons. Of this, from one fourth to one third is supposed to be contained in the arteries; and from two thirds to three fourths in the veins; (§ 379.) a large proportion of the whole, being in the arterial and venous capillary vessels. (§ 313.) In civic life, the ventricles of the heart in healthy adults, contract from seventy to seventy-five times in a minute; and it is supposed that the left ventricle throws into the aorta from one to two ounces of blood, at every contraction; and that a quantity equal to the whole volume of blood in the body, passes through the heart as often as once in three minutes. In a new-born infant the heart contracts about one hundred and forty times in a minute: in the first year of life, about one hundred and twenty-four times;—in the second year, one hundred and ten, and in the third year, ninety-six times in a minute. In the decline of life, the contraction of the heart diminishes in frequency, and in old age the pulse does not exceed sixty, in a minute. The rapidity of the circulation however, varies in different individuals according to different circumstances, habits, &c. In some men the heart regularly contracts more than four thousand times in an hour:—in others, less than three thousand. This difference, as we shall see hereafter, (§ 919.) as a general fact, depends much on dietetic and other voluntary habits.

§ 487. The blood, like the chyle and other substances of the body, has repeatedly been analyzed by the chemists, and we have been told the precise quantities of the muriate of soda and potash, of phosphate of lime, iron, sulphur, &c. &c. contained in it; but without the least

advantage to physiology, therapeutics or dietetics. On no one of these points, has the chemical analysis of the blood thrown the least ray of light:—for it is not with a fluid composed on the principles of inorganic chemistry, of certain proportions of certain chemical elements, that the physiologist or the physician has to do;—but, with a *living fluid*, elaborated by vital processes, and subject to the laws and conditions of vitality.

§ 488. The blood is most indubitably a living fluid, (§ 203.) and its vitality is susceptible of very considerable increase and diminution. That it has vitality in itself, has repeatedly been, and may easily be proved by conclusive experiments:—still however, its intrinsic vitality cannot long be sustained out of the living vessel to which it belongs. Taken from the living vase, it loses its vitality in a few minutes; but if a quantity of blood be confined to a portion of a living and healthy artery, its vitality will be preserved as long as the healthy vitality of the artery remains. The preservation of the vitality of the blood therefore, depends on the living vessels in which it flows, or rather, on the nerves of organic life, which preside over the functions of those vessels: (§ 219.) and the degree of vitality in the blood, varies with the general condition of these nerves;—and the general condition of these nerves, depends very much on the character and condition of the blood.

§ 489. If the quantity of blood in the system be excessive, there is a tendency to special or general congestion, inflammation and death.—On the other hand, if the quantity of blood be too far reduced, the functional energy of the nervous system is diminished, the conservative power of the blood-vessels is impaired, and the intrinsic vitality of the blood is commensurately lessened. Hence, if a healthy robust man be copiously bled, and then, several smaller portions of blood be taken from him at short in-

tervals, each successive portion will lose its vitality sooner than the preceding one. The specific gravity of the blood is little more than that of water: it has been affirmed however, "that the more perfect the organization of the blood, or the higher the degree of vitality it possesses, the greater appears to be its specific gravity."

§ 490. By some physiologists, the blood is considered a homogeneous fluid; while others assert that it is a complicated compound of all the substances which compose the various solids and fluids of the living body:—the substances of the bones, cartilages, ligaments, tendons, membranes, muscles, nerves, bile, salivary, gastric, pancreatic and other fluids, &c. &c.—ready formed, and all mixed up together in the blood, like the materials of the world in the fabled chaos:—and all that is further necessary for the arrangement of these materials, into the several structures and organs of the body, is to have the blood pass through certain strainers which are so constructed and situated, as to separate out, and retain each material in its proper place. But this is obviously an expedient to cover human ignorance with the guise of science; a purely hypothetical attempt to explain the operations and results of the vital economy, upon chemical and mechanical principles.

§ 491. While the blood is healthfully flowing in its living vessels, it is impossible for us to investigate its properties:—and it is equally impossible for us to know how soon our meddling with it may effect essential changes in its character.—The furthest therefore, that our knowledge of the living blood extends, is that, when first taken from the living and healthy vessels, and examined under a microscope, it is found to be composed of a fluid containing innumerable minute globules, which are surrounded by a kind of pellicle or tunic of coloring matter. (§ 469.

484.) A substance called fibrin, is also said to be contained in the blood: but there is reason to believe that the fibrin is nothing more than an arrangement of the globules just named, divested of their coloring matter; and that the fibrin as such, is not to be found in the actively circulating blood.

§ 492. When taken from the living vase and permitted to stand a short time, the blood coagulates; or a portion of it gathers into a thick clot, called the crassamentum, and the remaining portion is a thin, transparent fluid of a greenish and yellowish appearance and saltish taste,* and is called serum.—By washing the clot freely in water, its coloring matter is removed and it becomes white and has a fibrous appearance.—When putrefaction commences in the blood taken from the living body it attacks rather the coagulum than the serous portion, and this is true also of the chyle.

§ 493. This is as far as the *physiologist* can push his analysis of the blood:—and *this*, taken in connexion with several important facts and phenomena which constantly take place in the living system, justifies the conclusion that the blood is not a homogeneous fluid:—but naturally consists of innumerable globules or corpuscles of animalized matter, held in a fluid state by an aqueous menstruum, or diluent; and that *the vitality of the blood wholly resides in the globules*.

§ 494. I have said (§ 450.) that water appears to pass from the stomach into the circulation with very little, if

* It is by no means certain that the saltish taste of the serum of the blood is not wholly attributable to the dietetic use of salt. Dr. James, formerly of the United States army, informed me in the summer of 1836, that the soldiers on the remote western frontiers, used no salt with their food when he was with them, and that he found their sensible perspiration to be as free from the taste of salt as pure water.

any change:—and it is a well known fact, that all the absorbent vessels of the body pour their contents of every kind, whether assimilated or not,—whether salutary or deleterious, into the veins.—It is also, well known that large quantities of water, holding saline substances in solution, may be injected directly into the veins of living animals without destroying life.—Castor-oil and other medicinal substances may likewise be introduced in the same manner:—and alcohol and other poisonous substances pass unchanged from the stomach, and mingle with the blood. (§ 458.) Indeed, alcohol is sometimes present in the blood in so large a quantity and so concentrated a form, as not only to be readily detected by the senses of smell and taste, but also to burn freely with a blue flame when touched by a lighted candle. When death is caused by lightning, it is well known that the blood remains in a fluid state incapable of coagulating: and in several forms of malignant, putrid fever, the corpuscles of the blood are broken down and lose the power of coagulating: (§ 492.) and in some instances, there are manifest evidences that putrefaction has commenced in the globules of the blood before the life of the body is extinct.

§ 495. All these facts seem to prove conclusively, that the blood cannot be a homogeneous fluid;—and that the serum of the blood cannot possess any degree of vitality:—and they leave little room to doubt that, what is called the coloring matter which surrounds the vitalized globules, (§ 491.) *is intended to shield them from the pernicious properties or influences, of such foreign matters as may find their way into the blood-vessels, and become mixed with the serum of the blood.* While the animalized corpuscles remain in the lacteals and other vessels, where, in the normal state of the system, only assimilated fluids are permitted to enter, they are not invested with those

pellicles or coverings which become red in the lungs, or at least, not until they reach the thoracic duct, (§ 469.) and are about to pass into the veins; and when they finally enter into the arrangements of organized structure, they are again divested of those tunics;—and hence it appears that they are only thus covered while travelling in the common highway of the circulation where they are continually exposed to the contact and influence of foreign and unassimilated substances.

§ 496. It is probably, from the serous portion of the blood mainly, that the excrementitious secretions and exhalations are made; and the impurities which sometimes accumulate in the blood from special or general derangement of function, are probably contained in this menstruum:—and it is possible that they exert their deleterious influence first, on the nervous tissue of the blood-vessels, (§ 230.) and through them, on the nerves of organic life generally, producing irritation, and morbid affection, which involves the blood-vessels, and by them is communicated to the living globules of the blood, and thus producing a general fever, which is modified in type and symptoms by various circumstances.—Hence, the intense thirst which usually attends a fever, and which may be an instinctive demand for water, to displace the offensive serum and allay the preternatural heat and action:—and hence, also, the interesting fact, that pure, soft water, freely administered, is decidedly the most efficient febrifuge in nature. The most violent fevers have been subdued by it with astonishing rapidity, when the ordinary means of medical practice, had proved utterly ineffectual. I confess, however, that this is mere speculation: but it seems to me to be corroborated by all known facts relating to the subject. Yet I do not, by any means, suggest this, as a universal theory of fever:—but merely as one of the means by which fever is induced.

Animal Heat.

§ 497. The temperature of the human blood, I have said, (§ 129.) is, in a healthy state of the body, ordinarily about 98 degrees, Fah. It rises above, and falls below this point, some few degrees, in particular states of disease:—but in the vigorous health of the body, the differences in external temperature seem to have very little effect on it,—the blood being always about the same temperature, whether the individual is travelling upon the polar seas or under the meridian line.

§ 498. Many attempts have been made to account for animal heat, on the principles of inorganic chemistry:—and no one of them, as I have already observed, (§ 476. 477.) has been more ingeniously constructed, and more plausibly supported, than that of Mr. Crawford; and no one has been so generally received. And even yet, though the essential defects of Mr. Crawford's theory have been demonstrated, many physiologists seem disposed to cling to the notion that respiration is in some way or other, the immediate source of animal heat; because there appears to be a close relation, say they, between the degree of heat in the body and the quantity of oxygen consumed. But this reasoning appears to me to be very inconclusive. We have seen that the vital properties which constitute the functional powers of all the tissues and organs in the body, are rapidly exhausted by action, and that they are replenished entirely, by the constant supply of fresh portions of arterial blood. (§ 376.) This supply being withheld, the muscles soon lose their susceptibility to the stimulus of motion, and their power of contractility:—the sensorial power of the nerves is immediately suspended, and the nervous power is very soon lost. (§ 471.) We have seen also, that the blood

cannot be purified, renovated and fitted for the replenishment of the exhaustions of the system, without the function of respiration;—and that, oxygen is essential to this function. (§ 482.) In this view of the subject, oxygen is certainly essential to the calorific function or the production of animal heat;—but not as a chemical element, depending on its chemical properties and combinations. (§ 139.)

§ 499. Animal heat, like voluntary animal phosphorescence and electricity, is most unquestionably a result of vital function, depending immediately on the vital properties and functional powers of the nerves of organic life. (§ 228.) Whatever therefore, impairs the health of this system of nerves, diminishes the power of the living body to regulate its own temperature. Hence spirit drinkers, except when under the direct influence of the alcoholic stimulus, have less power to resist cold, in proportion as the health of their nervous system has been impaired by the poison. Indigestion also, and all other difficulties of the stomach and intestinal tube, connected with the general condition of the nerves of organic life, diminish the vital powers of reaction against cold.—Whether the production of animal heat, therefore, be a process of secretion, or a function peculiar to itself, or nearly resembling that of animal phosphorescence and electricity, I do not pretend to say:—but I am entirely confident that it is purely a vital function, depending immediately on the vital properties and functional powers of the nerves of organic life.

§ 500. The relaxing and debilitating effects of continued heat, always diminish the power of the body to sustain sudden and severe cold.—They also diminish the powers of digestion and general nutrition; and render the system more susceptible of injury from dietetic irreg-

ularities and excesses:—and on the other hand, except in special cases of disease; continued cold weather, if it be not too intense, invigorates all the functional powers of the body;—increasing greatly, its ability to generate heat and maintain a uniform temperature; and commensurately increasing the powers of digestion and general nutrition: but sudden and extreme cold depresses all the physiological powers of the system. (§ 229.)

§ 501. Heat, I have said, (§ 129.) radiates from the living body in the same manner as it does from inorganic bodies: hence, as a general fact, the temperature of living bodies, is lower near the surface, than in the more central parts; but this, by no means, sustains the conjecture that the calorific function is peculiar to the internal parts.—It is probably not peculiar to any particular part of the system, but is as universal as the distribution of the nerves of organic life, and the blood-vessels.

§ 502. The interests of the vital economy seem to require that the blood, under the vital control, should be easily preserved in a state of fluidity, and at the same time be capable of becoming solid with ease. And it appears from numerous experiments, that the blood most readily coagulates at its natural temperature of ninety-eight degrees, Fah.;—and that any considerable variation from this point, impairs, and even destroys its coagulating power.

Nutrition.

§ 503. The blood, being distributed by the arteries, to every part of the body which requires nourishment, (§ 485.) is regularly appropriated according to the wants of the several parts:—and, with most undeviating accuracy, and integrity, every structure is furnished with fresh

supplies of its own proper substance.—The bones, cartilages, ligaments, tendons, membranes, muscles and nerves, all continually receive new portions of homogeneous matter, elaborated by the vital processes from one and the same current of blood.—How these ultimate processes of assimilation or structure are effected is wholly unknown.—Various conjectures have been advanced on the subject, but they have begun and ended in guessing and hypothesis. I have already alluded to the notion (§ 490.) which attributes to the ultimate vessels the office of strainers, that merely separate from the blood substances already formed in that common fluid: yet it is well known that not a trace of gelatin has ever been found in the blood, although this substance probably enters more extensively into the solid forms of matter, than any other in the body. Some physiologists as I have said (§ 375.) have imagined that there is a system of vessels called exhalants connected with the capillary system, which perform the ultimate processes of nutrition. Other, and very eminent physiologists, suppose that the capillary extremities of the arteries, secrete and deposite in its proper place and manner, the substance of each particular structure in the body: and they assure us that, with the utmost powers of the microscope, they are unable to detect any difference between the vessels which secrete one substance and those which secrete another;—that even those which supply the teeth and those which support the brain appear extremely alike; and yet the substances which they secrete from the same blood, are as extremely unlike as any two in nature.—The vessels which form and nourish the cartilages, ligaments, tendons, serous membrane, &c. are said to circulate only white blood, (§ 185.) and some have supposed it is because they are too small to circulate the red globules; but this is a mere conjecture, and the

reason assigned, is of quite too mechanical a nature for a physiological explanation.

§ 504. From the commencement of chymification, to the ultimate function of structure therefore,—and indeed, to the ultimate function of decomposition and elimination of the effete, or worn out matter of the body, all the changes are unquestionably effected by the processes of vital chemistry, which decompose the simplest known forms of matter, (§ 139.) and whose analytical and synthetical operations are governed by laws peculiar to vitality, and in direct opposition to the affinities of inorganic chemistry. (§ 121—123).

§ 505. Besides supplying the ordinary wants of the body by the general function of nutrition, the vital economy possesses the power, to a certain extent, of repairing the injuries which are done to it by physical violence. If a bone be broken, or a muscle or a nerve be wounded, and if the system be in a proper state of health, the vital economy immediately sets about healing the breach. The blood which flows from the wounded vessels, by a law of the economy, coagulates in the breach, for the double purpose of stanching the wound, and of forming a matrix for the regeneration of the parts.—Very soon, minute vessels shoot out from the living parts, into the coagulum of the blood, and immediately commence their operations, and deposite bony matter where it is required to unite a fractured bone, and nervous substance to heal the wounded nerve, &c. But the vital economy seems not to possess the power of reproducing the true muscle, (§ 201.) and therefore when any fleshy part has been wounded, its breach is repaired by a gelatinous substance which gradually becomes hard, and sometimes assumes something of the fibrous appearance. It however, so

perfectly unites the divided muscle as to restore its functional power.

§ 506. In this wonderful process of healing, the little vessels employed in furnishing the matter for the several structures, seem to know precisely where to commence and where to end their labors: and unless disturbed and driven to irregular operations by irritating causes, they never leave their labor incomplete nor go beyond their proper bounds.—But under the constant abuses of the body,—when the nerves of organic life are continually tortured and the vital economy generally disturbed by the unhealthy habits of the individual, not only in the process of healing a wounded part, but in the ordinary function of nutrition, substances will be misplaced or imperfectly elaborated, and diseased structure will be the result.

Secretion.

§ 507. The common current of blood from which the solids of the body are elaborated, is also the source from which the different vessels (§ 331.) and follicles (§ 333.) and glands (§ 334.) exhale, or secrete (§ 330.) the aqueous fluid or vapor which everywhere perspires from the external skin, and from the mucous membrane of the alimentary cavity, (§ 339.) and of the lungs and nose and ears and eyes and every other part; and that which exhales from the serous membrane of the closed cavities (§ 178.) and moistens and lubricates the heart, (§ 368.) and all other organs and parts in the thorax and abdomen; (§ 175.) and that which moistens the brain (§ 272.) and the spinal marrow; and the glairy fluid which lubricates the joints (§ 185.) and the tendons, &c.; (§ 195.) and the serous fluid of the proper cellular tissue; (§ 171.)

and the adipose matter (§ 178.) of the same tissue; (§ 508.) and the marrow of the bones; (§ 179.) and the humors of the eye; (§ 409.) and the mucus (§ 333.) which everywhere lubricates the surface, and imbeds and protects the delicate vessels and nerves of the mucous membrane (§ 339.) and external skin; (§ 187.) and the oily matter which anoints the skin and hair; (§ 421.) and the wax of the ear; (§ 333.) and the tears (§ 413.) and the saliva (§ 340.) and the gastric juice (§ 332.) and the pancreatic fluid (§ 457.) and the bile (§ 461.) and the secretion of the kidneys and every other secreted and excreted fluid and substances of the body, which are subservient to the lubricating and solvent purposes of the vital economy, or are eliminated from the vital domain for the purposes of purification. But how these secretions are effected, we know as little as we do how the substances which enter into the solid structures are produced. All that is known on the subject however, warrants the conclusion that the vital forces possess something like a transmuting power; (§ 62.) as they continually elaborate from a few kinds,—and even from a single article of food and the atmospheric air, all the different substances of the body, with natures and properties so diversified, so different;—and which, when analyzed by the chemist, afford many substances which cannot be accounted for from any thing contained in the blood, nor upon any known principles of chemical analysis and combination. All these substances have been repeatedly analyzed and the chemical results precisely stated, but without any advantage to physiology or therapeutics. (§ 431.)

§ 503. Concerning the adipose matter or fat, which transudes from the arterial capillaries, or is, in some other manner, deposited in many parts of the cellular

tissue, (§ 178. 507.) different opinions have been entertained. It is contained in little cells which vary exceedingly in size, form and disposition, and which do not communicate with each other. It is said to be *always* found in the cellular tissue of the orbits of the eyes, the soles of the feet, the pulp of the fingers and that of the toes; and to be *frequently* found, and sometimes in great abundance, in the cellular tissue under the skin, and in that which surrounds the heart, kidneys, &c.; while in the eyelids, the interior of the skull, of the brain, the eyes, ears, nose, lungs, intestinal canal, glands and some other parts, it is *never* found, except as the effect of disease. The quantity of this oily matter or fat in the human body varies greatly in different individuals and in the same individual at different times. (§ 178) In some instances it constitutes a very considerable proportion of the bulk and weight of the whole body.—Various opinions have been entertained in regard to the use of this substance in the animal organic economy. In the orbits of the eyes, the soles of the feet, and other parts where it is most invariably found, it is supposed to serve the purpose of elastic cushions, giving facility to movements, diminishing the effect of pressure, &c. Under the skin, it is supposed, as a non-conductor of heat, to assist in preserving the natural temperature of the body, and protecting the vital domain from the effects of severe cold: and generally, it is thought to be subservient in some measure, to the lubrication of the solids: and also to prevent excessive sensibility. It is moreover, a prevailing opinion among physiologists, that the deposition of this matter in the cellular tissue, is a provision of nature against the emergencies of famine. They suppose that, when by any means, the food of an animal is long cut off, as in the case of hibernation or torpor through the winter,

the vital economy lays hold of its adipose deposits, as bees do upon their honey, and reconverts it into blood for the nourishment of the system: and this is inferred from the fact that, the bear and other hibernating animals, on entering into the torpid state for the winter, have generally a considerable quantity of fat in their bodies, and that when they come out in the spring, it is all gone, and they are exceedingly lean. But this does not appear to be conclusive. If an ox be stall-fed till he becomes very fat, and then put to hard labor for several months, he will lose a large proportion of his fat, even though he be as highly fed during the whole time of his labor as he was in the stall, and receive all the food that he will eat, and all that his vital economy can healthfully dispose of. But in this case, it will hardly be said that the adipose matter is re-absorbed for the nourishment of the system.—Again, if the fat be designed for the nourishment of the body during protracted fasts, &c., then if a very fat man, in the enjoyment of what is ordinarily considered good health, and a lean man in good health, be shut up together, and condemned to die of starvation, the fat man ought to diminish in weight much more slowly, and to live considerably longer than the lean man: but directly the contrary of this is true. The lean man will lose in weight much more slowly, and live several days longer than the fat man, in spite of all the nourishment which the latter may derive from his adipose deposits.

§ 509. That the adipose matter of perfectly healthy bodies, like the marrow of the bones, (§ 179.) is subservient to some important purposes in the organic economy, cannot be doubted: but it is not necessary to infer from any known facts, relating to it, that its extensive accumulation in the cellular tissue, is a provision of nature for nutrient purposes, nor that it is employed for

such purposes during long fasts.—We have seen (§ 314.) that in the grand operations of the vital economy, the two great processes of composition and decomposition are continually going on:—new matter is constantly added by the general function of nutrition, to every structure and substance of the body, and old matter is constantly withdrawn and eliminated by the general function of absorption and excretion, from every structure and substance.—In a perfectly healthy state of the system, while the functional power and integrity of all the organs is preserved, a nice equilibrium is always maintained between the two great processes. But if from excessive alimentation, want of exercise, or any other cause, this equilibrium be destroyed, and the function of nutrition becomes excessive, disease in some form or other must speedily result, or the vital economy must have some extraordinary mode of relief. More nutritious matter is received into the vital domain, than the wants of the vital economy demand, and more than its powers can regularly dispose of. None of the regular tissues or structures of the system can incorporate it, and it cannot be eliminated from the vital domain as fast as it is received. In this exigency it must be disposed of in the safest manner possible, as a temporary resource. The cellular tissue we have seen, (§ 158.) is the lowest order of animal structure;—the lowest in vital endowment and functional character: and of all the forms of this general structure, that in which the adipose matter is deposited (§ 178.) is the lowest species. In the cells of this loose tissue which is simply employed as a kind of web to connect other and more important tissues and parts, (§ 171.) the vital economy therefore, may with greatest safety, in its particular emergencies, deposit for a time, whatever substances it is obliged to dispose of in the most expe-

ditionous and convenient manner, and which it is not able to eliminate from the vital domain: for, in these cells, such substances are at the greatest remove from any important vital power or function, that they can be, within the domain: and hence it is that such substances are deposited in this tissue: and some of the substances which are deposited here, and in some cases retained for years, are of the most deleterious character, as we shall see hereafter. (§ 1275.) Is it not obvious therefore, that the adipose matter which results from excessive alimentation, is temporarily deposited in the cellular tissue as a necessary expedient of the vital economy, in its emergency?

§ 510. It is a general law of the vital economy, that when by any means, the general function of decomposition exceeds that of composition or nutrition, the decomposing absorbents always first lay hold of, and remove those substances which are of least use to the economy: and hence all morbid accumulations, such as wens, tumors, abscesses, &c. are rapidly diminished and often wholly removed, under severe and protracted abstinence and fasting. When by an excess of the general function of nutrition, a considerable quantity of adipose matter has been deposited in the cellular tissue therefore, if active exercise be considerably increased, or the quantity of food be considerably diminished, the decomposing and eliminating organs of the system, by all that their functions are relatively increased upon that of nutrition, will be employed in first removing the adipose matter, in order to restore the system to the most perfectly healthy condition.

§ 511. The accumulation of adipose matter in the human body therefore, always evinces more or less of diseased action in some of the organs concerned in the

general function of nutrition, and can only be carried to a very limited extent without degenerating into serious disease,—terminating either in morbid obesity, dropsy, or apoplexy, or reacting with violence on some of the organs belonging to the digestive apparatus. Hence the notorious fact, that almost every animal which is fatted and killed for human food, is actually in a state of disease when butchered.—It is extremely difficult—indeed nearly impossible to find, in the butchers' markets of any of our cities, a perfectly healthy liver from a fatted animal: and it is by no means an uncommon thing for fatted hogs to die of disease when just about to be killed for the market.

Size of the Body, Determinate.

§ 512. But since, by the general function of nutrition, new matter is continually supplied to every structure and substance in the body, from the commencement of our existence till death closes our temporal career, why do not our bodies continue to increase in size as long as we live? Why should they grow from the infantile form to the stature of manhood, and then entirely cease to grow, and remain, with slight variations of bulk, at a fixed size through life?—The general economy of nutrition by which the body attains to the ordinary stature of man, so far as we can perceive, continues its operations through life. What then defines the proportions of our bodies and fixes the limits of our growth? Human science can make no determinate reply to these interrogations:—and in his attempts to answer them, the physiologist can only reason from the general laws peculiar to living bodies, and from the phenomena, facts and analogies which indicate the laws that govern the development and determine

the form and size of all organized bodies. My own views on this interesting point will be presented in a subsequent lecture. Be it remembered however, that the difficulty in the case, is not in accounting for the matter which is constantly supplied to the body by the function of nutrition. Because as we have just seen, (§ 509.) there is in all living bodies, an economy of decomposition and elimination, as extensive as that of nutrition. But this economy is in active operation during the whole period of growth as well as in subsequent life:—and the question is, why, under the active and simultaneous operations of the composing and decomposing processes, the body should grow to a certain size, and then entirely cease to grow, and the two processes, as a general fact, balance each other ever after?—or if they do not, disease in some form or other, necessarily results.—In some rare instances it is true, the human body continues to increase in bulk, till it becomes an enormous and shapeless mass, as in the case of Daniel Lambert and others. But these are always cases of disease, and the subject seldom reaches the middle period of life. Indeed, as I have said, (§ 511.) all obesity or corpulence is a species of disease, and denotes a want of integrity in some of the functions of the system.

Decomposition.

§ 513. The general process of decomposition is supposed to be effected principally, by the lymphatics proper, (§ 387. 388.) which as we have seen, (§ 385.) arise from every surface and portion of the body; so that there is scarcely a particle of matter belonging to the whole organic system, which is not within the reach of their action;—and they are supposed to be continually

acting on every structure and substance in the body where the function of nutrition is performed,—gradually decomposing and resolving to a limpid fluid called the lymph, the hardest bones as well as the softest structures and still less consistent secretions and fluids of the system. And thus, by the constant and regular operations of the nutritive organs on the one hand, and the lymphatics on the other, every structure in the living body, is continually and simultaneously undergoing the processes of composition and decomposition, of renovation and decay. (§ 314. 509.) Particle by particle of new matter is constantly added to every structure, from the fluid blood; and at the same time, particle by particle of old matter, is constantly absorbed from every structure and converted to the fluid lymph. So that, while the organic constitution, and physiological identity of every structure and of the whole system, remain permanent through life, a continual change is taking place in the particles of matter of which our bodies are composed: and, according to the estimate of some physiologists, an entire change of all the matter in our bodies is completed as often as once in seven years. (§ 314.)

§ 514. Besides thus regularly absorbing the substance of the various structures, secretions, exhalations, &c. within the precincts of the vital domain, the lymphatics are also supposed to absorb the pus and other kinds of matter, which disease may cause to form or accumulate in any part of the system. If fluids accumulate in any of the closed cavities, these vessels are supposed to be the organs by which they are taken up and removed; and it is likewise supposed by some, that they are the organs which in the lungs and external skin, absorb the infectious and pestilential properties of an impure atmosphere, and

other foreign matters. But this last opinion may be considered questionable. (§ 451. 452.)

§ 515. The lymph has been regarded by some physiologists, as wholly excrementitious matter, which is returned to the circulation only for the purpose of being presented to the excretory organs, which eliminate the impurities of the blood. Others consider it as of a very different character and destiny. They say that the lymphatics, like the lacteals, (§ 465.) possess an assimilating power to a high degree; and that all the substances which they absorb of every description, are converted into a fluid closely resembling the chyle, (§ 469.) but of a more refined and sublimated quality; and that it is returned to the pulmonary and general circulation, to be appropriated to the most delicate and elevated purposes of nutrition. The correctness of this opinion however is somewhat doubtful. The lymphatics evidently possess an assimilating power (§ 451.) by which they convert many, if not all of the substances that they absorb, into a nearly homogeneous fluid, which mingles with the chyle in the thoracic duct, and passes with it into the blood-vessels. (§ 486.) And when supplies of food in the alimentary canal are exceedingly small or entirely cut off for a considerable time, the lymphatics unquestionably become much more active than usual, and prey upon the adipose and other substances of the body, (§ 510.) forming a lymph which may have many of the characteristics of the chyle and blood, and which may, to some extent, in such an emergency, serve the purposes of nutrition. But in the ordinary and undisturbed operations of the vital economy, when the alimentary organs are duly supplied with food, it is probable that the lymph, formed from the decomposed matter of the body, is mainly if not entirely an excrementitious substance.

Depuration.

§ 516. The impurities which are continually accumulating in the blood, by the return of the worn-out matter of the body, to the circulation, and by the absorption of such substances as are unfitted for the wants of the system, are incessantly eliminated or expelled from the vital domain by the excretory organs constituted for the purpose. The lungs, as we have seen, (§ 479.) are largely concerned in this work of purification. The liver (§ 460.) is associated in the same general function:—and the kidneys excrete a large proportion of the effete matter and other impurities of the blood. The mucous membrane of the alimentary canal also, participates to some extent in this office:—but the external skin (§ 331.) probably exceeds any other organ, and it has been supposed to exceed all the other depurating organs in the system, in the *quantity* of matter which it *eliminates*. It is in some measure a respiratory organ, corresponding in function with the lungs. (§ 479.) Like these, it continually consumes oxygen, and eliminates carbonic acid gas, and imperceptible vapor; and at times pours forth a flood of sensible perspiration. Foreign and unassimilated substances absorbed from the alimentary cavity are largely eliminated from the vital domain by the skin; and the decomposed matter of the body is continually passing off through this portion of the great limiting membrane. (§ 330.) Since the commencement of the seventeenth century the opinion has generally prevailed, which was advanced by Sanctorius, that the skin ultimately throws off, in the form of insensible perspiration, something more than one half of all the matter which enters the vital domain. Some modern physiologists have questioned the accuracy of this estimate; but it is admitted on all

hands, that the skin is one of the most important depurating organs of the system and that its healthy condition and functional integrity are of immense importance to human health and comfort.

§ 517. The depurating organs, as I have stated, (§ 239.) reciprocate with each other in function, to a considerable extent, even in the healthy state of the body, and in a diseased condition, vicarious function is often attempted. Copious perspiration diminishes the secretion of the kidneys, and on the other hand, a suppression of the cutaneous function, generally increases that of the kidneys. The skin and lungs reciprocate in the same manner. Excessive exhalations and excretions of the alimentary canal also frequently result from a suppression of the function of the skin, and, by whatever cause induced, they are always attended with cutaneous depression. But the welfare of the particular parts as well as of the whole system, requires that each organ should uniformly and vigorously perform the full measure of its own duty; because frequent excesses arising from an undue determination of fluids to any one part, lead to debility of the part, and often result in impaired function, imperfect assimilation, local disease, and general injury and death. In this manner, sudden suppressions of the functions of the skin often lead to diabetes and pulmonary consumption, by causing undue determinations to the kidneys, and lungs, and inducing inflammation and permanent disease in those organs. The liver also suffers from all want of integrity in the other depurating organs; and its derangements compel the skin and indeed, the whole system to make an effort to throw off the matter which it should have eliminated. Still more excessively morbid and extravagant attempts at vicarious function take place when the mammary glands and other organs

endeavor to perform the duties of the kidneys. But cases of this kind are very rare. Frequent enough however, to show the wonderful resources of the vital economy in extreme emergencies, and also to demonstrate the great importance of health and integrity in each and every organ.

Wear, Expenditure, and Disease.

§ 518. In the most healthful and correct performance of their functions, the several organs of the body necessarily suffer some waste of substance as well as expenditure of functional power. (§ 376.) But while the general economy of nutrition is properly sustained, the replenishment keeps pace with the exhaustion. By excesses and irregularities however, and every other means by which the constitutional laws and functional relations of the several organs are violated, not only is the system as a whole, made to suffer, but the particular organs are often made the seats of local disease and suffering.

§ 519. By painful experience, most of the human family who have numbered twenty years, know that the teeth may become the seats of distressing disease and decay:—the gums may become softened and flaccid and ulcerous and otherwise diseased. The tongue and other parts in the mouth, are subject to disease in a variety of forms. The salivary fluid and mucous secretions may be rendered extremely acrid and irritating to the parts over which they pass:—the salivary glands may become inflamed, enlarged, indurated and cancerous:—the nose, fauces, windpipe, meatpipe and other surrounding parts are liable to many distressing forms of disease. The lungs are subject to inflammation, ulceration and general decay;—

the heart and blood-vessels are liable to enlargements, ruptures, ossification and a variety of other forms of disease. Derangement of function, formation of calculi, chronic inflammation, change of structure, decay of substance &c. &c. may take place in the liver, kidneys and other glands. In short, there is not an organ, nor tissue, nor substance in the whole vital domain, which may not become diseased and prove the source of death to the body. The bones (§ 185.) may become dry and brittle: or they may ulcerate or mortify. The cartilages, (§ 185.) ligaments (§ 188.) and tendons (§ 195.) may also become dry and brittle, and lose their elasticity and ossify or be destroyed: and the nerves and muscles may suffer a change of structure and decay of substance.

§ 520. There are many external and foreign causes as well as internal disturbances, by which these diseases are induced; and which act upon the system at different points, and in various modes. But the alimentary cavity, is the principal avenue through which the causes of disease commit their depredations on the vital domain:—the stomach is peculiarly a centre of irritation and starting point of disease to the whole body. It is continually liable to be disturbed and irritated in itself, and always communicates its irritations more or less extensively and powerfully to other organs. (§ 297. 298.) The means by which its own function is disturbed and impaired, and itself made the seat of disease, are very numerous. Substances of every kind, which are not adapted to the wants of the vital economy, if introduced into the stomach, become the causes of a degree of irritation, always proportionate to the offensiveness of their character. Alimentary substances which are in themselves proper, if introduced into the stomach in an improper quantity, or condition, or at an improper time, or without suitable mas-

tication and insalivation, (§ 426.) necessarily become the causes of irritation, leading to local and general disease. The passions of every kind, and especially the painful and the violent,—all mental excitements, and severe mental application, (§ 304.) more or less affect the condition and function of the stomach, and often most injuriously; and if frequently repeated or long continued, they debilitate the organ and develop in it, a high degree of morbid irritability;—sometimes inducing inflammation, chronic and acute. In short, whatever is unfriendly to the vital properties, or impairs the nervous power and muscular contractility of the stomach, (§ 454.) or disturbs its function and deteriorates its functional results, always leads to disease of the organ itself, and tends to induce morbid irritability and sympathy, inflammation, thickening of its coats, softening and change of structure in the muscular and nervous tissues, scirrhus, cancer, &c. &c. And it is a remarkable fact that, when the integrity of the organic sensibilities and sympathies of the parts is greatly impaired or destroyed, by improper dietetic habits, (§ 296.) as is universally the case in civic life, irritations, functional derangements, and disease, even of the most fatal character, may be induced in the stomach and intestines, and slowly progress for years, and finally terminate in death, without ever being suspected by the subject, or affording such symptoms as lead to a detection of the evil, by the physician.

§ 521. But the stomach does not suffer alone in its irritations and diseases. All irritations disturb the functions of the stomach, and more or less impair the quality of the chyme, and this leads ultimately, to a deterioration of all the fluids and solids of the body. Besides, in all those irritations which affect the general condition of the stomach, the heart, lungs, liver and all the other organs

of the system sympathize, (§ 297. 298.) and by this sympathetic irritation, their functions are also disturbed and impaired. And, if, in consequence of hereditary peculiarities, or some other cause, the lungs, liver, or any other organ is particularly predisposed to disease, these sympathetic irritations always tend to develop it; and when developed, the local disease either reacts upon the stomach, and becomes a source of continual irritation to that organ, or serves as a kind of outlet, or concentrating point, by which the gastric irritations are relieved, and the stomach sustained in health, at the expense of the diseased part, which suffers from every error of diet,—from every gastric irritation however induced. Thus, continued gastric irritation often produces spinal irritation, which reacts with tremendous energy on the stomach,—in some instances completely destroying its functional power:—and on the other hand, disease may be induced in the lungs, liver and other organs and parts, by gastric irritation, and carried forward to the destruction of the affected part, and to the extinction of life, continually exasperated by the originating cause, while the stomach itself, seems all the while to be in excellent health, and the unfortunate sufferer is confident that nothing which he eats or drinks, or swallows as medicine, does him any injury, because “it sits well on his stomach.” In this manner, every organ and part of the human body, in its turn, may fall a sacrifice to the abuses and irritations of the alimentary canal;—and, with very few exceptions, fevers of every type, and acute and chronic disease of every form, may spring from the same source. With what propriety then, did the Psalmist exclaim, “I am fearfully and wonderfully made!”

LECTURE IX.

Nature of the soul—Immortality of man—Connexion of the soul with organized matter—The laws that govern it—Brain the seat of intellectual and moral faculties—Views of Gall and Spurzheim concerning the organs of the brain and the mental and moral faculties—Elements of intellectual and moral character in man and the diversities of manifestations—These phrenologists attribute to cerebral organization—The cerebral organs enumerated, described and located—Temperament and physiognomy—Combinations of faculties in forming character—Plurality of cerebral organs proved by the mental relief from a change of subjects—By monomania—The laws of mind in sanity and insanity—Its organic instruments—Special senses—Sight the source of imagery—The philosophy of vision—Mental perception—Mental conception—Reflection—Perceptions of the different senses not reproduced with equal ease and vividness—Associations of perception and reflection—Associations of reflection, conception, and propensities and sentiments—Mental effects of intoxicating liquors in religion, &c.—The Mind cannot perceive two distinct objects at once—nor perceive and conceive distinctly at the same time—Perfect sleep—Dreams, how produced and affected—Conceptions of the poet, &c.—Distinct conception takes away the power of perception at the same instant—Dreams, and conceptions while awake, realities to the mind while they last—Nervous irritation, how it produces mania—All the feelings and affections by whatever produced enter into the mental operations and affect the judgment—hence according to the feeling so the conclusions—As we *feel* on a subject, so is its importance to our mind—Wine, music, beauty—their effects—Strict mental sanity defined—Insanity, what, and how caused—Mind always true to its laws—How far this favors phrenology—Does local disease of the brain cause insanity?—Insanity from irritation in the domain of organ-

ic life—Phrenology makes the brain too exclusive—Intellectual and Moral Physiology the true science.

§ 522. WE have seen that all matter—if not essentially a single element, (§ 72. 87.) consists of a very few primordial substances:—(§ 73.) and that the same matter is common to all material forms,—(§ 49.) both inorganic and organic:—(§ 112. 118.) that the various forms of matter, are produced by the different arrangements of the same primordial atoms:—(§ 80. 106.) and therefore, that the nature of a thing, depends, in no degree, on the matter of which it is formed; but entirely on the constitutional laws of arrangement:—(§ 140.) and these laws, it is contended, do not arise from the intrinsic properties of matter; (§ 83.) but are imparted to it, by an omnipotent, and infinitely wise and benevolent Creator: (§ 89.) and from the constitutional nature of things thus established, all their properties and powers arise. (§ 140.)—We have seen also, that, the most primitive laws and properties, imparted to matter, are those which belong to inorganic forms: (§ 106.) and that the laws and affinities of inorganic matter, are directly adverse to the laws and affinities peculiar to organic matter: (§ 107.) and consequently the arrangement of matter in the formation of organized bodies, is the effect of the operation of constitutional laws which suspend and overcome the laws and affinities of inorganic matter: (§ 110.) and hence the constitutional laws and properties peculiar to living organized bodies, cannot arise from inorganic matter, nor result from the operations of any of the laws or affinities of inorganic matter: and therefore the constitutional laws and properties, peculiar to organized bodies, were superinduced, and established in the permanent economy of organic vitality, by an omnipotent and infinitely wise and benevolent Creator. (§ 89.)

§ 523. The same train of reasoning is equally applicable to the differences existing between vegetable and animal forms of matter; (§ 114.) and the properties and powers peculiar to animal bodies:—and also, to the differences existing between the cellular, muscular and nervous tissues of animal bodies; and the properties and powers peculiar to each of these tissues. (§ 312.)

§ 524. It is not, therefore, in the nature of things possible, that vitality, nor any of the properties peculiar to the living tissues, should spring from the intrinsic properties or powers of matter; (§ 108.) nor from any organic arrangement of matter:—but, on the contrary, the organic arrangement of matter, is always necessarily the effect of vital action:—and the properties and powers, with which each tissue is endowed as a living substance, arise, not from the arranged matter of the tissue, but from the vitality residing in the tissue.—The vitality of the different tissues, differs in degree; and there is reason to believe that, the vitality of the muscular tissue is of a higher order than that of the cellular tissue; and that, the vitality of the nervous tissue is of a higher order than that of the muscular;—and that, the vitality of some parts of the nervous tissue, is of a higher order than that of other parts:—and it is possible that the vitality of some portions of the brain is of a higher order than that of others.

§ 525. But when we speak of the laws and properties of matter, what do we mean? (§ 88.) We talk of the law of gravity;—and so far as the size, weight, distance, velocity, &c. of attracting bodies are concerned, we can reason with mathematical accuracy and precision:—but with all the extent and accuracy of knowledge in regard to the fixed order of the phenomena of gravity, what do we know of the essence of that power which we call the attraction of gravitation?—Absolutely nothing!—

The chemist also speaks of the molecular affinities of matter, and the laws which govern the combinations of his experimental elements: yet he is totally ignorant of that power or property which he calls affinity; and the fixed order of whose phenomena, he calls law.—The astronomer and the chemist therefore, cannot from their knowledge of the essences of things, either affirm or deny that *the power which produces all the physical and chemical phenomena of matter, is the omnific and omnipotent spirit of God.*

§ 526. We use the word law then, in regard to matter, as an abstract term, to signify a fixed order of phenomena that are produced by a power of which we are entirely ignorant. Hence all evidences of design and of final causes, go, without any draw-back, to prove—either that an omnipotent and intelligent first Cause continually exerts a direct and controlling influence on matter;—or that, the *essential nature* of each form of matter (§ 140.) which governs all the phenomena of its particular form, and which is the substratum of all the properties and powers of its form, was originally established, and is continually sustained in a permanent constitutional economy, by the Creator.

§ 527. While therefore, we cannot, from our knowledge of things, affirm what the essence of life is, (§ 41.) we know, as certainly as we know any thing concerning matter, that it could not spring from any of the properties or powers of inorganic matter:—and that its relation to the organization of matter is of necessity in the nature of things, and has ever been, since the first establishment of the vital economy in connexion with organized matter, that of a cause and not of an effect. (§ 108.) Hence it may be boldly affirmed, that no man possesses knowledge which justifies the assertion, that the power which governs

the organization of the nervous system of animal bodies, and constitutes the substratum of all its properties and powers, is not a substance essentially different from matter. Nor does any man know any thing contrary to the idea, that this substance may differ in different orders of animals.

§ 528. Purely as physiologists then, with all the light of science around us, we can, with at least as much philosophical propriety, affirm that, *the substratum of the sensorial power of the human brain, (§ 524.) is a spiritual substance*, as any one can affirm the contrary:—and the truth of our affirmation, is infinitely more probable, than it is that, mind and moral feeling are results of organized matter. It is frankly confessed however, that, as *mere physiologists*, we can offer no evidence of the future existence of man.—This, of necessity, in the nature of things, is purely a doctrine of revelation.—As metaphysicians, we may reason very forcibly to such a conclusion from what we regard as moral evidence, and general analogy, and from the intellectual and moral fitness of man for such an existence: but, apart from the sacred Scriptures, we have no *decisive proof* that man will exist in a future state.—But while it is true that physiology affords no evidence of man's future existence, it is also true that, it affords no proof to the contrary:—and the important fact that, all the bearings of the Gospel of Jesus Christ, on the present state of human existence, accord most perfectly in all respects with the physiological laws of our nature, almost amounts to a demonstration that the doctrines of that Gospel concerning our future existence are true. (§ 613.)

§ 529. Since therefore, physiology cannot prove that, the sensorial power of the human brain is a property of matter, nor that it is a result of the peculiar organization

of the matter of the brain; and since all that we know of the laws and properties of matter, is adverse to such a notion; and since the Gospel of Jesus Christ, which comes to us with the strongest possible evidence of its divine authenticity, explicitly affirms the existence of a soul in man which shall exist beyond the grave eternally, it may be boldly affirmed that the human soul is an immaterial substance, and that it constitutes the substratum of the sensorial power of the human brain; and no man can show from the demonstrations or facts of science that this opinion is not strictly philosophical; and the most probable of any.

§ 530. It is entirely certain however, that, whatever be the substratum of the sensorial power of the human brain, it resides in and acts through the organized matter of the nervous substance—during our present state of existence, precisely the same as if it were merely a property of that vitalized matter; and all its powers and manifestations are subject to precisely the same laws as govern the powers and manifestations of vitality.—This truth is of immense importance to every human being! Indeed! it lies at the very foundation of intellectual and moral and religious philosophy, and is of vital interest to human happiness in every point of view.—Instead of neglecting it therefore, as a matter unworthy of our consideration, or of regarding it as of secondary importance, or of combating it with vain assertions and denunciations as heretical, we should diligently study to understand it, in all its depth and breadth and bearings and relations.

§ 531. Should it be asserted that this doctrine proves the immortality of the lower orders of animals equally with that of man:—I reply, 1. that, according to the views which I have advanced, there may be an essential difference

between the substratum of the sensorial power of the nervous system of the lower animals, and that of the sensorial power in the human brain: (§ 527.) 2. that, the immortality of man, or his future existence, does not depend on the nature of his soul, but on the will and power of the Creator. The human soul, equally with the human body, depends on God for its existence; and if we exist in a future state, it will be purely because God wills it, and not because the human soul is self-existent. Therefore unless it can be shown that God has revealed the doctrine of the immortality of the lower animals as explicitly and fully as he has that of man, then my reasoning does not in any manner go to prove the immortality of the lower orders of animals. But it is not the business of physiology to prove the immortality of the human soul, and it is not possible for it to prove the contrary.

§ 532. In regard to the particular seat of the human soul, different opinions have prevailed at different periods of time; and amongst different nations:—but it would neither be interesting nor instructing, to review, on the present occasion, the various theories and speculations which have been advanced on this subject. The human brain is unquestionably the more immediate and special organism of the mental and moral powers:—and the grand question before the world at present, is whether the mind acts in and through the brain, as a single organ, or as a system of organs. This question has indeed, been agitated to some extent, ever since the time of Aristotle; and probably, ever since the human mind first began to speculate on the relations between mind and body:—but it has been made a more prominent object of contemplation and inquiry, in our own day, by the theory which has been advanced by Dr. Gall and advocated and improved by Dr. Spurzheim and others. (§ 274—279.)

§ 533. Without stopping to review the progress of this theory from its origin to the present moment, I shall proceed to present a brief abstract of it, as it last came from the hands of Dr. Spurzheim.—According to this theory, as I have already stated, (§ 267. 268.) the brain is composed of diverging and converging fibres of medullary substance, which are so arranged as to form in connexion with the pulpy or gray matter of the brain, a system of duplex organs: and each pair of these organs are a specific and distinct faculty. (§ 275.)

§ 534. The organs are divided, according to their functional character, into Propensities, Sentiments and Intellectual Faculties. The Propensities are situated in the lower and back part of the skull, and are all common to man and the lower animals. The Sentiments occupy the upper portion of the skull, and are subdivided into those which are common to man and the lower animals; and those which are peculiar to man. The Intellectual Faculties belong to the fore part of the skull, or the forehead, and are subdivided into perceptive and reflective faculties.

§ 535. This Theory claims to be purely inductive, and to be founded on the correspondence between the conformation of the brain, as evinced by the shape of the skull, and the mental and moral character:—and is called Phrenology or the doctrine of the mind.

§ 536. It is a matter of common knowledge that, the greatest diversity of propensity, sentiment and habits of thinking and of acting, are continually manifested in society, by different individuals; and that this diversity may be traced through all stages of civilization and all periods of life; and often exists in a very remarkable degree even in small families.—Some individuals have an intense, instinctive love of life, and always contemplate death—

or the extinction of life, with the deepest dread and even horror: and this too, without any regard to the pain of dying:—while others seldom think of death, and have so little regard for life, that, were it not for their dread of the pain of dying; or, of what may follow the death of the body, they would, on slight occasions of disappointment and vexation, throw life away.—Some individuals are habitually given to the excesses of the table, and regard the indulgences of the palate, as the highest and almost the exclusive enjoyments of life:—indeed, they often seem not to have the power to refrain from these indulgences, even when they know that disease and suffering must inevitably be the consequences of their yielding:—while others seem to eat and drink from a mere sense of duty, to sustain the body; and never run into excesses.—Some are extremely tender and gentle and merciful in all their actions and are habitually careful to destroy nothing that can be of use to themselves or to any one :—while others even from early childhood, evince a disposition to destroy almost every thing they can lay their hands on, and delight in killing flies and other animals, and often become murderers of their own species.—Some manifest an eager desire to enter into wedlock as early in life as possible, while others coldly prefer celibacy, and spend their life, from choice, in single blessedness.—Some discover the greatest fondness for little children, and seem to prefer their society to any other.—In some mothers the maternal feeling is supreme, and all the energies of their soul seem to yearn over their own sweet babes:—by day and by night—in health and in sickness—in prosperity and adversity—in honor and ignominy, they cling to them, and hang over them in maternal devotedness, and are never weary of supplying

their wants and administering to their comforts. As the bosom of waters over which "the viewless winds" flap their hasty wings, so is the face of such a mother when her children are acting or suffering before her,—every emotion which they manifest, and almost every movement which they make, ripple her countenance into expressions of pleasurable or painful sympathy. Nor are her sympathies confined to her own children,—she has always a smile for the playfulness of other babes and a tear for their sufferings. Such mothers even in the midst of penury and privation, consider their children their greatest earthly blessings, and never regard them as burdens under any circumstances. Others have the greatest aversion to little children, and can never bear their presence but with disquietude and annoyance.—If such are mothers, they perform the maternal duties in a cold and heartless manner, and are continually complaining of the toil and vexation which their children cause them; and are frequently heard to say how much better off they should be without children. Such mothers, in whom there is a want of the proper restraint of moral sentiment or of education, will abandon, and in some cases, even destroy their own babes.—Some persons are extremely fond of society and are strongly inclined to form the attachments of friendship and to become attached to particular things, which they are accustomed to: while others seem to be isolated beings,—shut up within themselves and having no sympathies, either for men or things.—Some are powerfully attached to their home and native place and country and are zealous and devoted patriots: while others are equally at home in all places and have no love for any country.—Some are peaceable and meek, and timid and cowardly: while others are

bold and full of courage and perhaps contentious and turbulent and quarrelsome, and always ready to fight on the slightest provocation.—Some are excessively open and frank and communicative—blab every thing they know and hear and think; and never can keep a secret, nor practice any concealment nor hypocrisy: they seem indeed not to be able to conceal their sentiments even when they know their own welfare requires it; while others are always secret even in regard to trifles, and wrap every thing in concealment and mystery:—they never speak without first considering what they are going to say, and whether it can in any manner be turned to their disadvantage:—they seldom give a prompt and direct answer to an interrogation; but reply in an indirect, ambiguous or evasive manner: and are frequently sly, crafty, hypocritical and knavish, and given to falsehood.—Some are excessively prodigal and improvident, and have no disposition to acquire any thing: while others have a strong desire to possess every thing they see; and are prompted to the most diligent and indefatigable efforts to acquire great possessions, and perhaps are extremely parsimonious and covetous, and avaricious; and in some cases the propensity is so great that it leads to habitual theft.—Some seem to possess no aptitude to construct even the simplest kinds of machinery: while others evince an irresistible propensity to be engaged in some kind of mechanical employment, and with astonishing aptitude, soon become masters of the most difficult mechanical arts; inventing and constructing the most complex pieces of mechanism as if the whole were a result of peculiar intuition.

§ 537. Some individuals are extremely incautious and rash: while others are very circumspect and excessively cautious.—Some are perfectly reckless of the

opinions of others, and have no desire for approbation and distinction:—while others are extremely sensitive to the slightest expression of disapprobation, and feel a continual and powerful desire to be the objects of attention and admiration and praise; and have a deep and fervent longing for renown and glory, and immortality of fame.—Some have little self-confidence and self-respect; and always throw themselves upon a level with those in whose company they may happen to be: while others feel a great degree of self-confidence,—self-esteem and self-importance:—they speak as if they thought themselves the very oracles of wisdom—are exceedingly reserved and dignified and perhaps consequential in their manners; and often haughty, and contumelious.—Some seem to live only for self: all their actions and all their plans of life, begin and end in self. They feel no interest in the common welfare of mankind, and no sympathy for any cause which aims at the improvement of the condition of their species: while others appear to lose self in their extended feelings and plans and efforts of benevolence and philanthropy. Their feelings and their thoughts are continually occupied in devising and maturing, and carrying into operation, schemes of benevolence by which mankind may be made better and happier. They are kind hearted, and affectionate and merciful to every human being; and indeed to every thing that feels.

§ 538. Some feel great respect for superiors; and great deference for traditionary authority: and the most solemn reverence for the supreme Being:—while others seem to want these feelings entirely.—Some possess great firmness and decision and perseverance, and resoluteness; and stubbornness and obstinacy; and love to exercise authority and to command: while others are

unstable and yielding and submissive and obedient.—Some are exceedingly conscientious in every thing they do, say, and think; and always desire to be strictly just in all their dealings; and if they think they have wronged or in any manner done the slightest injustice to any one, they cannot rest till they have set the matter right:—while others seem almost totally destitute of conscientiousness, and even pride themselves in their dishonesty and fraud and knavery; and boast of their success in over-reaching, deception and cheating.—Some are full of hope and expectation of good things to come: while others are inclined to despondency and despair.—Some are extremely credulous, and strongly inclined to believe every thing that is associated with mystery and with the marvellous and supernatural: while others are sceptical in every thing,—wholly reject the marvellous—deny the existence of a God, and almost doubt their own existence.—Some are exceedingly ardent and enthusiastic, and have the most vivid and vigorous imaginations, and behold every thing with poetic vision and feelings; and to them, the earth is a paradise or a purgatory and the human species are angels or devils:—while others are always the same, unvarying, cold, matter-of-fact beings, who estimate things by weight and measure; and regard the visions of the poet as the hallucinations of a diseased brain, and his enthusiasm, as the excitement of insanity.—Some are always full of mirth, and facetiousness, and wit, and jest, and drollery, and satire:—while others are habitually sober, and serious and saturnine.—Some have a powerful inclination and wonderful aptitude, to imitate and mimic the actions, gestures, voice, expressions, &c. of men and animals; while others have neither the disposition nor the power to imitate any thing.

§ 539. Some are remarkable for noticing with great

minuteness and accuracy, individual persons and things, and all the peculiar habits, qualities and appearances of individuals: while others pay no attention to such things.—Some have a great aptitude to notice and judge of forms, figures, and features, and remember countenances with great accuracy: while others are very deficient in this power.—Some are remarkable for the power of measuring distance, size, &c. by the eye. Others will judge of weight with astonishing accuracy: and others have the nicest perception of colors in all the delicate varieties of hues and tints: while others seem almost totally destitute of these powers.—Some persons are remarkable for their power of perceiving and remembering the relative situations and localities of external things and all the features of a landscape; and are exceedingly fond of travelling and of seeing new places and countries: while others are the very opposite of this in all respects.—Some are very notable for their great precision and systematic arrangement and order in all they do and say:—every thing belonging to them is kept in the most precise order: while others are as notably careless, and slovenly and destitute of method and order.—Some are remarkable for their power of numeration; and will run through processes and arrive at results in numbers with a promptitude and accuracy which seem absolutely supernatural: while others are scarcely able to carry through a simple process in arithmetic.—Some are astonishingly accurate and minute in their knowledge of particular events; and seem to have the whole history of the world in detail, stereotyped upon their brains: while others are utterly incapable of remembering particular events; and can only retain general impressions and fundamental principles.—Some will remember dates and the successive periods of events with wonderful accuracy:—while others

find it impossible, even with the utmost labor, to impress dates upon their memory.—Some seem natural instruments of music; and have only to open their mouths and the air issues from their lungs in the most enchanting tones and strains of melody:—while others seem incapable of learning a tune, or even of distinguishing one tone from another.—Some have a wonderful affluence and facility of language:—they commit language to memory, and learn new languages with great ease; and are never at a loss for words:—they remember names with astonishing accuracy: and in some instances, they are capable of talking or speaking for hours with grammatical accuracy, and even with rhetorical richness of language, while at the same time they seem to be like mere hand-organs, uttering well-ordered sounds without a thought.

§ 540. Some are remarkable for their very acute and discriminating power of comparison: while others are very deficient in this faculty.—Some have an irresistible inclination and a wonderful power to search and find out the causes of things; and are always in pursuit of first principles; and delight in philosophic investigations; and are exceedingly fond of original pursuits and enterprises and discoveries: while others are in all respects the very opposite of this; and prefer to trudge along the common beaten track of the world; taking things as they come, in the shape of separate facts and individuals, and never give themselves a care, or entertain a thought about causes and general principles and relations.

§ 541. Now, according to phrenology, the elements of all these differences and diversities, are constitutionally innate; and depend entirely on cerebral organization, development, and activity:—each of the propensities and sentiments and intellectual faculties, being prominent

and vigorous, or obscure and feeble, according to the size and activity of that particular part of the brain which is its special organ: and the relative size of the several organs being evinced by the general proportions of the head and the particular elevations or depressions of the outer surface of the skull.

§ 542. By carefully examining the heads of a great number of living, and the skulls of many dead persons and animals, and comparing their general and particular proportions with the mental and moral character and peculiar propensities and habits of the individual, Dr. Gall succeeded, as he believed, in ascertaining the particular location of twenty-seven pairs of the cerebral organs. (§ 275.)—Following the same inductive method, as he affirms, Dr. Spurzheim has added several pairs to the number described by Dr. Gall, and has left us the description and location of thirty-five pairs of these organs; and has named two other pairs,* the localities of which, are not yet fully ascertained. (§ 279.)

§ 543. Thus then, according to this theory of Phrenology, we are furnished with thirty-seven pairs of cerebral organs, which are the seats of all the animal instincts, and of all the moral and intellectual powers that we possess; and which are precisely adapted to the condition and wants of the body and to the great purposes of individual and social life. Each pair of organs perform a separate and distinct function:—and “the essential nature of each primary power,” says Dr. Spurzheim, “is one and invariable, and no organ can produce two species of tendencies.”

Propensities common to Man and the lower Animals.

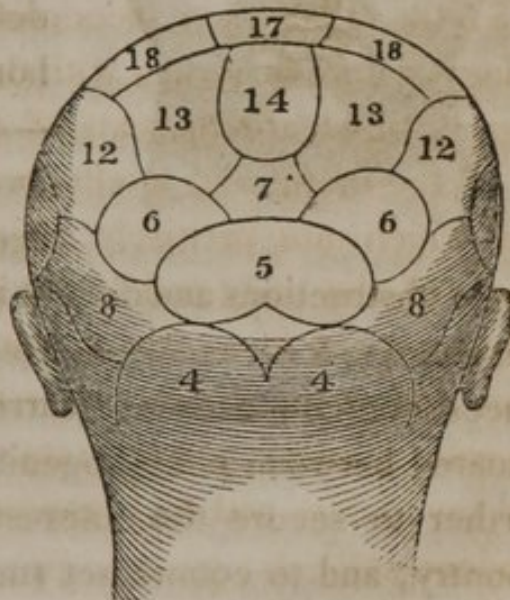
§ 544. If we enumerate the cerebral organs in the most philosophical order, (§ 536.) we shall begin with—

* Vitativeness and Alimentiveness.

1st, Vitativeness; or the organ of the instinctive desire of life. This is supposed to be situated at the base of the brain, where the middle and posterior lobes meet.—To sustain life, we have—2d, the organ of Alimentiveness; or the instinct that prompts us to take food. This is supposed to be situated before the ear, immediately under acquisitiveness and before destructiveness.—To supply the alimentary and other wants of the individual,—to demolish and destroy whatever is hurtful



to the body or endangers its existence and well-being, or whatever the good of the individual requires, we have—3d, the organ of Destructiveness; or the propensity to destroy; or more properly, the propensity to satisfy, or execute the demands of the other instincts, at all events, even though it require the demolition and destruction of other things, or whatever stands in the way, or opposes: and therefore, when unduly developed and active, or greatly depraved by bad education and habits, and unbalanced by counteracting moral organs, it produces cruelty, ferociousness, and murder. This is situated immediately above the ear.—To secure the multiplication and perpetuity of the species, we have—4th, the organ of Amativeness, which consists of the two lobes of the little brain; situated at



This is situated immediately above the ear.—To secure the multiplication and perpetuity of the species, we have—4th, the organ of Amativeness, which consists of the two lobes of the little brain; situated at

the base of the skull, behind,—over the back of the neck.—For the protection and cherishing of offspring, we have—5th, the organ of Philoprogenitiveness; or the instinctive love of children,—the maternal feeling. This is situated at the back part of the head immediately above amativeness.—To secure the connexions and institutions of domestic and social life, we have—6th, the organ of Adhesiveness,—or the instinctive propensity to form attachments to things and friendships with persons. This is situated at the side of philoprogenitiveness, and a little above.—And to secure the more extended interests of do-



mestic and social life, we have—7th, the organ of Inhabitativeness, or the instinctive love of home, of native place, and country;—giving rise to patriotism, &c. This is situated immediately above philoprogenitiveness.—For the defence of self and family and home and country, we have—8th, the organ of Combatitiveness—or instinctive courage, or the propensity to over-

come obstructions and difficulties—to resist opposition, repel attacks, &c.; and when excessive and unbalanced, produces contentiousness, quarrelsomeness, &c. This is situated between philoprogenitiveness and the ear.—Still further to secure the interests of self and family and country, and to counteract and defeat superior force by management or stratagem, we have—9th, the organ of Secretiveness;—or the instinctive propensity to secrecy, concealment, slyness, cunning, craftiness, &c. This is situated a little above destructiveness.—To provide for the wants of self and family, and to sustain the

institutions of society; we have—10th, the organ of Acquisitiveness; or the instinctive propensity to acquire property, or whatever may be useful to us, or minister to our wants,—the desire to possess—disposition to be provident, &c.; and when excessive and unbalanced, produces parsimony, covetousness, avarice and theft. This is situated before and a little above secretiveness.—For the protection and comfort and convenience of self and family and society, we have—11th, the organ of Constructiveness, which leads to the building of houses—the construction of all kinds of machinery, &c. This is situated at the temples above the cheek bones.

Sentiments common to Man and the lower Animals.

§ 545. To secure that circumspection and prudence, and discreetness, and caution which our condition and circumstances in life, render necessary for individual and social welfare, (§ 537.) we have—12th, the organ of Cautiousness, which is situated at the back corners of the head,—above, and a little behind the ears.—To prompt us to seek the good will and favorable opinion of others, and to incite us to the performance of those public and private deeds which serve the best interests of society, and become the foundations of honorable distinction and fame, we have—13th, the organ of Love of Approbation, or the instinctive desire for distinction, which in the excess leads to vanity and ambition, and the restless strife for public applause and glory. This is situated between cautiousness and the crown.—To secure a proper stability and dignity of deportment and character, and to prompt us to undertake those deeds and enterprises, which we have the ability to perform, and which private and public good requires, we have—14th, the organ of Self-Esteem;

which in the excess leads to personal pride, haughtiness, superciliousness, contumeliousness, &c. This is situated at the crown of the head.—To secure that gentleness and affectionate conduct, and kindness of demeanor, and mercifulness, which are so essential to the happiness of domestic and social life, and those philanthropic efforts and enterprises which the public good requires, we have—15th, the organ of Benevolence; which is situated at the top of the forehead—near where the hair commences.

Sentiments peculiar to Man. (§ 508.)

§ 546. To secure that respect for the opinions of others, and especially for the aged, the experienced and the wise, and that reverence for superiors, and for the authority of those that have lived before us; and most of all, to secure that deep and solemn veneration for the Supreme Being, which the individual, and social and civil good of man requires, we have—16th, the organ of Reverence; which is situated at the top of the head, mid-way between the crown and the forehead.—To give us fortitude, decision and perseverance of character, we have—17th, the organ of Firmness, which in the excess degenerates into wilfulness, stubbornness, obstinacy; and becomes a desire to exercise authority, and to command. This is situated at the top of the head, next in front of Self-Esteem.—To check our many selfish propensities, and to secure individual and civil integrity and righteousness, we have—18th, the organ of Conscientiousness, or the instinctive disposition to do right, to be just. This is situated on the side of firmness,—or between firmness and cautiousness.—To sustain us under the numerous discouragements, and continued disappointments of life, and to support us even when the “life of life is gone,” and

nothing of this world, either in possession or in prospect, remains to cheer or comfort us, we have—19th, the organ of Hope; which leads us on from day to day, with expectations of good things to come; and when it can no longer cling to the promises of this world, it stretches forward and lays hold of the promises of a future state of being. This is situated by the side of veneration.—To sustain the hope of life and peace, and happiness beyond the grave, and to prompt us to look for those evidences which will afford us the belief of the existence and continual care and benevolent purpose of the Supreme Being, we have—20th, the organ of Marvellousness, or instinctive disposition to “look through nature up to nature’s God.” This is situated in front of hope.—To exalt the mind “to all sublimer things,”—to afford us the most elevated conceptions of truth and moral beauty and the perfectibility of things, and to stimulate us to the noblest and most honorable deeds, we have—21st, the organ of Ideality; which is situated about mid-way between benevolence at the top of the forehead, and the ear.—To break up the monotony of life, to give elasticity to our energies, and variety to our emotions, and to increase the pleasures of our social intercourse, we have—22d, the organ of Mirthfulness, or instinctive disposition to facetiousness, wit, pleasantry, drollery, satire, &c. This is situated at the corners of the forehead, in front of ideality.—To enable us to represent our ideas of men and animals by signs, and tones, and gestures; and to acquire the necessary and the useful and the elegant arts of society, we have—23d, the organ of Imitation; which is situated between mirthfulness and benevolence.

§ 547. Of the PERCEPTIVE OR KNOWING FACULTIES of the mind, (§ 539.) we have—24th, the organ of Individuality, or instinctive disposition to notice objects in their

individual capacities, habits and peculiarities. This is situated between the eyebrows.—25th. The organ of Configuration, or the instinctive disposition to notice figures; and power to recollect persons and forms, seen before.—26th. The organ of Size, or the instinctive disposition to notice size, measure, distance, dimensions, &c.—27th. The organ of Weight, or the faculty of judging of the weight of things, &c.—28th. The organ of Coloring, or the faculty of nicely discriminating colors, hues, tints, &c.—29th. The organ of Locality, or the faculty which perceives and remembers the situations, and relative localities of external objects, and leads to the love of travelling.—30th. The organ of Order, or the power and inclination to perceive and observe order, and method, and precision of arrangement.—These last six organs, are situated in the range of the eyebrows;—arching from the inner to the outer corners of the eyes.—31st. The organ of Calculation, or the faculty of numeration, and calculation in general. This is situated at the outer corner of the eyes towards the ears.—32d. The organ of Eventuality, or the faculty of acquiring a knowledge of events and occurrences, and of noticing and remembering every thing that happens, and which leads to historical knowledge. This is situated in the centre of the forehead, immediately above individuality.—33d. The organ of Time, or the faculty which perceives and retains the succession of events,—remembers dates, &c. This is situated on the outside of eventuality towards the temple.—34th. The organ of Tune, or the faculty which perceives harmony and discord; and imparts the ability to sing and to compose music. This is situated at the outer corner of the forehead between wit and order.—35th. The organ of Language, or the faculty of acquiring and retaining a knowledge of words, and of lan-

guages; and the power of remembering the names of persons, things, places, &c. This is situated behind the eyes, and when large, causes the eyes to stand out prominently.

§ 548. The REFLECTIVE FACULTIES (§ 540.) consist of two pairs of organs—36th. The organ of Comparison, or the special power which compares the functions of all the other primitive faculties; and discerns resemblances, analogies, identities and differences. This is situated between eventuality and benevolence.—37th. The organ of Causality, or the faculty which perceives the connexion between cause and effect,—leads to the investigation of causes and to the idea of the First Cause of all—God. This is situated on the outer side of Comparison.

§ 549. The ancient doctrine of temperaments and the somewhat more modern one of physiognomy were at first disregarded, or wholly repudiated by the phrenologists, and the relative size of each organ, and the general volume of brain, were considered the principal or exclusive evidences, of the power of the single and collective propensities, sentiments and intellectual faculties. So that, a large mass of brain, in a normal or proper state, was regarded as the sign of large powers; and the intellect, sentimentality, or animal propensities, of the individual were said to predominate according as the cerebral mass lay more in the front, or upper, or lower and back part of the skull.—But it did not require very extensive observation to lead to the inductive conclusion that, the capacity of the forehead is not always the measure of the intellectual powers, even in a well-proportioned head. For, while it may be true as a general fact, according to the common impression of all ages, that the most extraordinary minds which have at different

periods in the history of the human race, impressed their unperishing energies upon the world, have had their seats in capacious foreheads and been connected with large brains, yet we may everywhere meet with individuals with large heads and capacious foreheads, who possess no extraordinary powers of mind; but in some instances are remarkable for their stupidity;—while on the other hand, we everywhere meet with active and powerful minds in comparatively small heads, and rather low and narrow foreheads.—To meet these difficulties, the doctrine of temperaments has been invoked in its fullest extent: and finally, physiognomy has become completely associated with craniology in the present theory of phrenology.

§ 550. The size and general proportions of the head, the particular prominences of the skull, the temperament and the physiognomy of the individual, are all therefore, to be taken into consideration in judging of the intellectual and moral character of persons.—Or in other words, both the size and activity, or energy of the cerebral organs are to be considered: and to ascertain the activity or energy, the temperament is called in, and physiognomy is an important index of temperament and of the mental and moral and animal energies of the brain.

§ 551. No organ however, is to be judged singly and absolutely, but relatively. As for instance, if we find combativeness largely developed, we are not therefore to conclude that the individual is a disputatious, contentious, quarrelsome fellow, who is continually in a brawl and fight:—but if we look still farther we may find that acquisitiveness, and cautiousness, and love of approbation, and benevolence, and conscientiousness, and ideality, and causality, are all likewise largely developed. In such a case the conflicting elements will qualify and regulate each other, so as out of the whole to form a harmoni-

ous unity of character.—Combativeness will carry the individual forward with an energy which will surmount every obstacle, and subdue every resistance and overcome every opposition, or perish in the attempt:—acquisitiveness will prompt him to pursue a course of gain:—love of approbation will prompt him to seek his gain in a manner by which he may distinguish himself and be the object of applause:—benevolence will lead him to seek his gain and glory, in some enterprise of philanthropy, which aims at the general welfare of mankind:—causality will lead him to pursue his enterprise of gain and glory and philanthropy, in an original track and manner and in a philosophic form:—ideality will give an elevated character to his enterprise and enthusiasm to his efforts:—conscientiousness will prompt him to be strictly just and righteous in all his principles and measures and operations and actions, by which he seeks to gratify his combativeness and acquisitiveness and love of approbation and benevolence and causality and ideality:—and cautiousness will prompt him to be extremely careful to do nothing that will forfeit, or jeopard his interest, or his fame, or be in the least degree, inconsistent with his principles of philanthropy, and strict righteousness; and cause him to examine all the principles of his philosophy, with the most rigid scrupolosity and by the severest test of facts and experiments.—With such an organization therefore, the individual if successful, would, like a Franklin, acquire wealth and fame, in a manner which is not only consistent with, but highly conducive to the general welfare of his species; and strictly compatible with the purest and noblest private virtues.

§ 552. The phrenological theory of Dr. Gall, I have said, (§ 535.) claims to be purely inductive: and it is

apparently supported by innumerable facts and coincidences; and is now too extensively received, and too ably advocated and defended, to be treated with ridicule or neglect. Every honest mind therefore, which is thoroughly imbued with the spirit of truth, will endeavor to examine it with candor and integrity, and neither seek to support, nor to demolish it by any unfair means. If it be true, no one should wish to oppose it.—If it be erroneous, no one should wish to defend, nor to cover its errors. Yet if I mistake not, neither its opposers nor defenders have at all times, manifested that candor and honesty which should always characterize our inquiries after truth.

§ 553. I am sure that I speak honestly, when I say that, I have no prejudices against this theory; but am favorably inclined towards it:—yet candor obliges me to acknowledge that, I am not so fully and entirely convinced of its truth, as some of its zealous adherents appear to be. Being early addicted to physiological investigation, and habituated to the closest observation of the mental and moral manifestations of man, in connexion with the physiological and pathological conditions of the body, I had arrived at, and was accustomed to teach those doctrines of intellectual and moral physiology which I still continue to advance, long before I heard of Dr. Gall, or of his theory of phrenology.—I do not however, intend to insinuate that any thing like the views of Dr. Gall, in relation to the general shape and particular prominences of the skull, as connected with the mental and moral manifestations of the individual, had ever entered my mind;—except the common impression in regard to the capaciousness of the forehead, &c.; nor do I claim to have conceived of the plurality of organs in the brain. I had however, embraced, and publicly advanced

the opinion, that the nerves of special sense and all the other nerves and parts within the cranium, and indeed the whole cerebro-spinal system of nerves, (§ 232—307) have a common centre of perception, at, or near the top of the medulla oblongata; (§ 280.) but this was then purely an hypothesis inferred from the phenomena of mental and moral physiology.—My attention had been directed almost entirely to the intellectual and moral manifestations as affected by the physiological and pathological conditions of the body; and to the analysis of the intellectual and moral powers as connected with the brain and nervous system as a whole: and in these pursuits I had arrived at the opinions which I still entertain in regard to intellectual and moral physiology;—many of which are now claimed by writers on phrenology, as belonging peculiarly to that theory.

§ 554. There certainly appear to be many and strong reasons for believing that the brain consists of a plurality of organs, and that these particular organs perform special functions; and also that there is a correspondence between the external shape of the skull and the intellectual and moral character of the individual. Nevertheless it must be acknowledged that, none of these points has yet been conclusively demonstrated, and therefore they must still be regarded as at least in some measure, problematical.

§ 555. One of the principal positions urged in support of this theory, is that, when the mind has been severely applied to a particular subject till it becomes weary, if it be directed to another subject, it is instantly relieved, and feels comparatively fresh and vigorous. This, it is said, proves the plurality of organs in the brain; as the relief experienced arises from a change of the special organs in the mental operations:—or in other words, that

by turning the mind from one subject to another, the weary organ is left to rest, and a fresh organ is called into exercise:—for how, it is asked, could relief be experienced by a change of subjects, if the brain acted as a single organ? But this seems to suppose not only that there is a plurality of organs in the brain, but also that each individual organ possesses the capacity and power of carrying on a process of perception, reflection, reasoning, &c. independently of the other organs. Yet according to the general theory, the reflective faculties are more or less actively employed in all processes of reasoning, investigation, inquiry, &c.; and therefore, whatever may be the subject to which the mind is applied, the reflective faculties must be exercised in every act of reasoning.

§ 556. If I understand the theory, the power of each special organ is a simple element of the mind, and not a complex power: and all these elements together, constitute the *one mind*; and not a complex assemblage of minds:—and in proportion as one or another of these elements, enters more or less largely into the mental constitution, so is the mind qualified and characterized. If this statement is correct, then it is evidently unphilosophical, on phrenological premises, to suppose that one organ or any number of organs can be so exclusively employed on one subject, as that a change of the subject will call into action a wholly new set of organs, and leave the weary ones to rest. For whether the subject be algebra or geography or chemistry or any other, some of the same faculties are always principally employed in every process of reasoning. Simple perception may be performed by a single organ as an element in the mental constitution, but when reflection, comparison and reasoning take place, other organs must also be called

into exercise, and organs too, which are always more or less concerned in every act of reasoning on every subject.

§ 557. Moreover, the fact assumed in the case is very questionable.—If two bushels of salt be placed on a man's shoulder and he carry it till he becomes weary, and then if the salt be taken off, and two bushels of oats be placed upon the same shoulder, the man will feel greatly relieved, and it will almost seem to him that he has no load at all.—And so in the labors of the mind;—if we apply our thoughts to a particular subject, till—to use common language—the mind becomes weary, and then turn our attention to some light and amusing subject, we certainly feel much relieved. But if the mind be severely employed on a particular subject, till painful weariness is experienced, and then be applied with equal severity, to another subject, which requires an equal degree of mental power, so far shall we be from experiencing any relief, that the weariness will continue, and increase, till it becomes intolerable.—Sometimes the mind is greatly relieved by changing the question without changing the nature of the subject. As for example:—we may attempt the solution of a question in the science of numbers, and by some accident or mistake, embarrass the mental associations in some of the processes, and continue to labor without success, till the mind—as we say—becomes extremely weary and confused or confounded; and then we may turn immediately to another equally difficult question in the same science, and the mind will feel at once, and very considerably relieved; and will perhaps, solve the question with very little difficulty; and then return to the former question, and solve that too, in less than one fourth of the time that was devoted to it at first;—and finally, quit its labors with

less sense of weariness than was felt when it turned to the second question. But does this prove that in changing the question, we change the organs also?—and that we have different organs for different problems in mathematics? Evidently not!—On the whole then, I conceive that this position when properly examined, neither proves any thing for, nor against the theory of Dr. Gall.

§ 558. Another, and perhaps the most important position advanced in support of Dr. Gall's theory is that, we frequently see people totally insane on one subject, and perfectly sane on all others; and it is contended that, this fact can only be accounted for by admitting a plurality of cerebral organs, and that one of these organs is diseased.—This position is strictly consistent with the philosophy of the general theory, and may be correct;—and if so, is very conclusive:—while on the other hand, if it can be proved to be incorrect the general principles of the theory may nevertheless be true.

§ 559. The consideration of this position will necessarily lead us over the whole field of intellectual physiology. For, in order to ascertain what *insanity* is, we must first determine what *sanity* is; and this renders it necessary that the elements and laws of mind should be clearly ascertained. In speaking of insanity however, it is highly important that the meaning of the term should be accurately understood. Strictly speaking, the mind in itself, is incapable of insanity. It is governed by certain general laws, which it always, and under all circumstances and conditions obeys. Even in the worst cases of madness, the mind is true to its own laws; and in obeying these laws, exhibits what we call insanity.

§ 560. We have seen (§ 530.) that whatever be the substratum of the sensorial power of the human brain, it resides in and acts through the organized matter of the

nervous substance, during our present state of existence, precisely the same as if it were merely a property of that vitalized matter, and all its powers and manifestations are subject to precisely the same laws as govern the powers and manifestations of vitality; and this is equally true whether the brain be a single organ or a system of organs.—We have seen also, (§ 242. 251. 252. 253. 254. 294. 295. 397. 398. 403. 409.) that man possesses several organs of special sense, all of which convey their impressions to the cerebral centre of perception, (§ 280.) from which they are reflected to the mental organs. We have the special sense of touch, (§ 253.) of taste, of smell, of hearing and of sight. Hunger, (§ 247.) and all the other feelings or senses by which the cerebral centre has cognizance of the specific wants of the vital economy, are likewise as truly special senses as taste, smell, hearing and sight.

§ 561. The effect produced on the organs of these senses and through them, on the cerebral centre, by the action of appropriate stimuli is what we call *perception*: but neither the hemispheres of the brain, (§ 265.) nor the lobes of the little brain, (§ 264.) are essential to animal perception. (§ 259.) Some portion at least, of the hemispheres of the brain however, is essential to intellectual perception.

§ 562. The sense of sight is the exclusive source of imagery to the mind. When the light is reflected from any object upon the retina of the eye, (§ 252.) certain impressions are made upon the retina which are perceived by the mind; or in other words, by which the mind has a perception of the object.

§ 563. There has been a good deal of speculation about the physiological and psychological philosophy of vision, (§ 415.) but the eye has too generally been treat-

ed as merely a mechanical organ, and considered as entirely passive in the function of vision: and hence, it has been compared to a camera obscura with its inverted image, &c. (§ 416. 417.) So far as regards the mechanical and physical philosophy of vision, this is all well enough; but it does not explain the vital and mental function.—It does not inform us how the animal sees the object.

§ 564. In one respect at least, there is an essential and very important difference between the eye and the camera obscura:—the optic nerve with its expanded extremity, forming the retina, is a living organ, endowed with a peculiar sensibility to all the properties of things which are perceived by the medium of light:—but this sensibility depends on the connexion of the optic nerve with the centre of animal perception, and on the healthy condition of the parts. And the perception being made by the organ in connexion with the animal centre, we do not actually see things inverted as has been generally supposed, because the mind does not perceive the inverted image formed upon the retina of the eye, as we perceive that of a camera obscura: but the image formed upon the retina of the eye, instead of being perceived by the mind as an image or representation of an external object, constitutes what may be called the *stimulus of visual perception*, by which the external object itself is really seen. Or in other words, the colors and all the other qualities of the image caused by the light reflected from an external object, are the real *visual properties* of the object, and are to the living organ, so many specific kinds of visual stimuli, giving to the parts on which they act, the impressions which being perceived by the animal centre, (§ 280.) constitute the animal perception of the real external object: and therefore, the perception of the several parts

of an external object is always made with reference to the direction of the rays of light which convey the stimuli; and consequently all external objects are seen in their natural and real position.

§ 565. When for instance, the rays of light which are reflected from a person, animal, tree, or any other external object, fall upon the retina of the eye, an exact image of the object is formed on the retina, but as the rays of light cross each other, (fig. 51.) before they reach the retina, (§ 416. 417.) the image is inverted and turned side for side; but this image is not perceived by the mind, as the image or representation of the external object, but all the elements and qualities of the image act on the peculiar sensibility of the optic nerve, as specific and delicately modified stimuli: or in other words, they are the real visual properties of the external object, which act as the appropriate stimuli on the retina of the optic nerve, in perfect analogy with the action of gustatory, olfactory and auditory stimuli on their appropriate organs.

§ 566. The peculiar sensibility of the gustatory nerve, (§ 294.) in connexion with the animal centre of perception, feels those properties of things which it is adapted to perceive, as sweet, sour, bitter, &c., and this is the perception of taste. The peculiar sensibility of the olfactory nerve feels those properties of things which *it* is adapted to perceive,—as the various odors, and this is the perception of smell. The peculiar sensibility of the auditory nerve, feels those properties of things which *it* is adapted to perceive, as the various undulations or vibrations of air, &c. causing sound, and this is the perception of hearing: and in precisely the same manner the peculiar sensibility of the optic nerve feels the visual properties of things, and this is the perception of sight. And thus the visual properties of external things as really

and truly act upon the optic nerve, as the olfactory and gustatory properties of external things do upon the nerves of smell and taste. In each case the appropriate properties are brought in contact with, and act upon the nerve, as appropriate stimuli, producing specific impressions or sensations, which the mind perceives as the properties of the real things, and in perceiving these impressions or sensations, the mind always refers them to the things from which they are received; according to the constitutional laws of the particular function. And consequently the inverted image formed upon the retina, instead of being perceived as an image or representation of the external object, is felt as the visual properties of the real object itself, the same as its tangible properties are felt by the organ of touch—the gustatory properties by the organ of taste, &c.; and therefore the impressions or sensations produced by these properties, as the appropriate stimuli of the organs, are instinctively and necessarily referred to the real external object, whose visual properties act upon the organ, and in the direction of the rays of light which convey the properties to the retina. Thus, though the visual properties of the top of an object, (fig. 51.) are thrown upon the bottom of the retina, yet from the constitutional laws of the function of vision, we instinctively and necessarily refer the impression or sensation to the top of the object, in the line of the rays of light by which the properties are conveyed to the retina, and consequently, we actually see things just as they really are; unless we see them through distorting media; or through bodies which bend the rays of light, and change their colors before they reach the eye.

§ 567. Whether the optic nerve itself, or some other part, is the seat or receptacle of those impressions or sensations which constitute the mental ideas of the visual

properties of external things, is not yet ascertained and perhaps never will be: but wherever the seat may be, it is certain that those impressions or sensations may be *reproduced* without the presence and actual perception of the external things by which they were first caused, and *this reproduction* is called *mental conception*.

§ 568. We have a visual PERCEPTION of an external object when it is really before us and we actually see it; or when its visual properties are actually thrown upon the retina of the eye: and we have a visual CONCEPTION of that object, when, in its absence, we reproduce the impression or sensation first caused by the action of the visual properties of the object on the retina:—or in other words, when the mind distinctly perceives the external object, without the real visual function of the eye:—or without actually seeing it:—for, the instant the impression or sensation is distinctly reproduced the mind instinctively and necessarily refers it, according to the laws of visual perception, (§ 564.) to the external object by which it was first caused: and thus by perfect *conception*, the external object is made to stand as clearly and distinctly before the mind as it does in the real act of *perception*. And when our mental conception of external things is vivid, distinct and complete we call it IMAGINATION.

§ 569. When a perception is made, it is instantly reflected to the intellectual faculties, and the reflected impression or sensation becomes a more abstract property of the mind, and is capable of being reproduced at any time, without actual *perception* or real *conception*, (§ 568.) and this is called REFLECTION.

§ 570. But our reflections always tend to produce conceptions, and are always the most clear and vigorous when our conception is the most vivid and distinct: and

hence the writer or speaker who, when writing or speaking, has the most vivid and accurate conception of the things of which he treats, always presents his subject most clearly and eloquently, and always produces the most powerful effect upon his readers or hearers, by presenting to their minds most vividly and distinctly the images of his own.

§ 571. Conception also greatly assists reflection by enabling the mind to contemplate, examine, analyze and compare things which have been perceived; and, by ascertaining the accidental and essential differences, resemblances and identities, to arrive at general conclusions and first principles, and thus elaborate the general theory of things.

§ 572. The power of recalling or reproducing the thoughts of reflection (§ 569.) in their regular associations is called **MEMORY**; and consequently memory, while it is a single attribute of the mind, is nevertheless, according to phrenology, of diversified power, and pertains to each individual organ of the brain: so that, we may have a very good memory on one subject and a very poor one on another, according to the relative activity and power of the individual organs.

§ 573. Visual perception, (§ 568.) I have said, (§ 562.) is the only source of that conception (§ 568.) which presents imagery to the mind. Auditory perception is also a source of mental conception, but to a more limited extent than that of vision: and we are much more rarely capable of reproducing the distinct impressions or sensations of auditory perception than we are those of vision. The reflected impressions or sensations (§ 569.) of auditory perceptions are however, very easily reproduced, especially when the power is cultivated, as in music. But except in dreams and disease, we never distinctly

hear sounds by conception. The perceptions of smell, taste and touch, are also rarely the sources of mental conception except in dreams and disease.*

§ 574. The succession of our perceptions establishes certain relations between the sensations of perception, and also between the thoughts of reflection, (§ 569.) so that, the reproduction either of a sensation of perception or of a thought of reflection, naturally tends to the reproduction of others associated with it:—and this is what is called the ASSOCIATION of ideas,—the law of association, &c.—The perceptions of the different senses become associated in the same manner.—Thus we look at a certain figure and hear it called A till we learn so completely to associate the visual and auditory perceptions in our thoughts of reflection, that they become inseparable, and indeed, seem essentially one; and the name becomes the mental abstract of the thing:—and, except in cases of actual perception or conception, (§ 568.) all our thoughts are of this kind;—a species of algebraical abstraction or nominal representation in the mind, of things existing separately from the mind. Thus, we write and talk rapidly of trees, animals, men, &c. without having distinct images of the things we write or speak of presented to the mind. But as I have said, (§ 570.) reflection always tends to produce conception, and it rarely if ever becomes energetic and determinate, without producing some degree of conception, or

* Mr. James Hill, a respectable farmer of West Cambridge, Mass., now about sixty years old, and in pretty good general health, entirely lost the sense of smell ten years ago, and has smelled nothing since;—not even the strongest and most pungent and offensive odors. Still the sense of touch remains perfect in the nostrils. Mr. Hill says he often dreams of smelling and has a distinct and full conception of odors, especially the offensive. June 1, 1838.

reproducing to some extent the primary sensations of perception. (§ 568.)

§ 575. The sensations of perception, both in their primary form, as reproduced in conception, (§ 568.) and in the form of thoughts of reflection, (§ 569.) are also intimately associated with our animal appetites and moral feelings: so that, the perception, the conception, and even the thought of certain things, will arouse certain appetites or propensities, or excite certain emotions or feelings:—and, on the other hand, the emotions or the appetites will call up the thoughts and conceptions. Thus, if we intently think of any kind of delicious fruit or of any food of which we are fond, conception will soon present the fruit or food distinctly to the mind's eye; and the animal appetite for it will soon be roused, and perhaps become even painfully importunate: and on the other hand, if the appetite be excited by the want of the vital economy, the thoughts and conceptions of something fitted to gratify the appetite, will instantly be produced; and if the appetite be specific and determinate, the thing thought of and conceived will be specific.—So likewise, if our perceptions of things are constantly attended with certain moral precepts, admonitions or feelings, our conceptions of those things will always remind us of the associated sentiments; and generally, if not always, reproduce the associated feelings:—and our thoughts of those things always tend to produce the conceptions, (568.) and thus excite the emotions. And, on the other hand, if the feelings be produced by a physiological or pathological condition of the body, the thoughts and conceptions are called up, and the mind contemplates the thing thought of, as the cause of the feeling. (§ 302—305.) Thus, if an individual is devoutly and zealously religious, and always contemplates the favor of his God with

pleasurable feelings, that physiological condition of his body which, in common language, is called a happy flow of animal spirits, will be sure to call up his religious thoughts and conceptions, and he will consider the feeling as entirely of a religious and spiritual character and origin. So likewise, if he is accustomed to the use of tea, coffee, wine, tobacco, opium or any other alcoholic or narcotic or other stimulant, the pleasurable stimulation which he receives from his stimulant, will, unless his attention is directly engaged in some other matter, call up his religious thoughts and conceptions, and he will attribute his happy frame to his religion:—and on the contrary, if from the pernicious effects of his stimulant on his nervous system, or from some other cause, a physiological depression results, a general feeling of distress or unhappiness will be induced, which will fill his mind with religious doubts and fears, and he will attribute his feeling entirely to those doubts and fears; or both the doubts and the feeling, to the withdrawment of the favor of God.

§ 576. It is not possible for the mind to perceive two separate and distinct objects of thought at one and the same instant:—nor is it possible for the mind to have a distinct perception and conception (§ 568.) at one and the same instant. When the mind is occupied with a distinct perception of things, no mental conception can take place; and when it is occupied with a distinct conception, perception is wholly suspended. Thus, when we are completely absorbed in a reverie, or in that state in which the mind is perfectly engrossed in the contemplation of its own conceptions, the functions of all our organs of sense, are totally suspended, and we no more perceive any thing by sight, hearing, smell, taste or touch than if all our organs of sense were paralyzed. It is

indeed, a perfect dream.—The instant we are conscious of a perception, (§ 561.) the ideal presence vanishes and the reverie is destroyed. The ability to retire within ourselves from the perception of every thing around us, and shut the mind up to its conceptions and reflections, is called the power of ABSTRACTION, or in the language of phrenology, concentrativeness. But the constant action of the appropriate stimuli of vision, hearing, smell, &c. on the sensibilities of our organs while we are awake, renders it difficult for us to become as perfectly abstracted from the consciousness of surrounding things as when asleep, and therefore our mental conceptions are generally most vivid and distinct and the ideal presence most perfect in our dreams, when our external senses are locked up in sleep. For dreams are nothing more than the more or less perfect reproduction of the sensations of perception, with a varied extent of associated reflection. Whether thoughts of reflection (§ 569.) are first excited and lead to conception, (§ 568.) or conception is first induced and excites thoughts of reflection, in dreams, is not certain. Perhaps sometimes one and sometimes the other.

§ 577. In perfect sleep, there is a total suspension of all the functional powers of the nerves of animal life, (§ 228. 229.) and we neither dream nor are conscious of our existence. When we dream therefore, our sleep is imperfect; and it is rendered imperfect by some nervous irritation, or some physiological oppression or depression in the body; and this disturbing cause, whatever it be, is also the exciting cause of our dreams; and the character of our dreams, as to pleasantness or unpleasantness, always corresponds with the nature and degree of the nervous irritation and the general condition of the nervous system; and especially the nerves of

organic life. (§ 228.) Most frequently however, the exciting cause of dreams is some irritation in the digestive organs: (§ 297. 298. 299.) but this is not always the case.

§ 578. Whether asleep or awake then, when our *conceptions* (§ 568.) are complete or perfect, they are as much realities to the mind as our actual *perceptions*: (§ 561.) and it is only when our conceptions have given place to actual perceptions that we know that the conceptions are not real perceptions. Nothing is more real to the mind than dreams while they last.—We do not—we *cannot* know them from realities until they cease to be, and we wake to reality and find we have been dreaming. And this is strictly true of our day dreams or *ever es*, and of all our mental conceptions.—The conceptions of the poet or the painter in what is called his moments of inspiration, are as real to his mind as his actual perceptions, and their effects upon his body are generally even more powerful: and when his conceptions are vivid, distinct and complete, it is impossible for him to know, or to have the slightest suspicion, while they remain, that the ideal presence is not a reality.—If, in the moments of his high and powerful conceptions, we should see the poet, without impairing the spell of his soul, in the least degree, and behold the intense meaning of his eye and all the workings and expressions of his countenance—his violent gestures—his sudden starts—his hurried or suspended respiration, and hear him break forth in his soliloquies or in his addresses to the beings of his imagination, with tender, melting tones, or with terrible vehemence, and fierce impetuosity, we should certainly believe him to be a raving maniac, and probably, as others have done before us, shrink with shuddering dread from such fearful manifestations of insanity. Yet in all this the poet's mind operates in

strict accordance with those general and fixed laws which govern every human mind; and is no more insane than the mind of the merchant is, when it is so completely engrossed in the conceptions of things that relate to his mercantile business, that, he walks along the public street of the city, without knowing whom he meets or what he passes.—The only difference is that, the conceptions of the poet are of a more exciting character and produce a more extensive and powerful effect on the whole nervous system; causing correspondent looks, gestures, &c. Besides, the general nervous excitability of those who are what we call poetic and other genuises, is much greater than ordinar ; and in fact, this is the principal element of all genius.

§ 579. Perception and conception (§ 568.) I have said (§ 576.) cannot take place at one and the same instant, and hence our conceptions are generally the most vivid and distinct and perfect in dreams, when the organs of perception are sealed up in sleep:—and hence also, nervous people generally prefer to have a light in their bed-rooms during the night, so that, they can see things distinctly when they are awake, and thus be able to prevent disagreeable conceptions, by actual perceptions. Upon the same principle, if an individual who is much afraid of dogs, is walking along the street in the day-time, and sees a large stone by the way, he does not mistake it for a dog, because he distinctly *perceives* it to be a stone:—but if it be at night when it is too dark for him to have a distinct perception of the stone, the *indistinct perception* may instantly give place to a *distinct* and vivid conception of a dog, and while the conception lasts (§ 578.) the dog will stand as distinctly before his mind as if it were an actual perception:—and the same effects will be produced on his whole mind and body.

§ 580. No man is suspected of insanity because he dreams in his sleep; and if one who is accustomed to do so, gets up in his dream, and with his eyes open but without *perceiving* any thing, walks about and acts and talks according to his *conceptions*, we still say he is dreaming;—but if he should remain in this state through the night and the following day, we should unhesitatingly pronounce it a case of insanity. Yet the mind would strictly observe the same laws that it does in ordinary dreams, and the same that govern it always when awake.

§ 581. The exciting cause of dreams, somnambulism, &c. I have said (§ 577.) is nervous irritation. When the system is perfectly healthy and undisturbed, sleep is death-like—a total and perfect suspension of all the functional powers of the nerves of animal life (§ 228.) and of all consciousness of existence: and the organs of external perception are, as it were, paralyzed to all external impressions, until the full purposes of sleep are effected, and the instinctive economy of organic life throws open the windows of the soul and restores every sense to its appropriate organ. The nervous irritation which produces dreams, may be carried to such an extent of disease as will cause such a constant succession or permanence of distinct and vivid conceptions when we are awake, that our mind will be mostly or entirely engrossed with these conceptions, and almost wholly abstracted from actual perceptions. The things conceived will be realities to the mind (§ 578.) and we shall think, feel, talk and act the same as if our conceptions were real perceptions: and then, of course, we shall be called insane. If the nervous irritation runs so high as totally to engross the mind in its conceptions, and causes us to see all surrounding things as the objects of our concep-

tions, transforming our friends to savages, demons, &c., we shall be said to be totally insane, and perhaps, raving maniacs; according to the degree of nervous irritation.

§ 532. The constant contemplation of things conceived, as realities, will soon establish new associations of thought and feelings, (§ 574. 575.) and thus lay the foundation for permanent insanity, even when the general nervous irritation has much subsided.—For intellectual habitudes of every kind are easily formed, and when once established, are with great difficulty broken up, and especially those which are associated with our feelings and propensities.

§ 533. When the nervous irritation is less violent, and has been developed in connexion with certain qualifying circumstances and corresponding operations of the mind, as the loss of property, character, friends, &c., the morbid conceptions may be limited to a single subject, and then the case will be called monomania, or insanity on one subject;—the mind being sound on all other subjects.

§ 534. Yet it is obvious that in all this, the mind observes the same laws that govern all human minds at all times. (§ 559.) The soundest mind in the world regards its *conceptions*, while they continue, as *real perceptions*; (§ 578.) and thinks, feels and acts, accordingly: and the insane mind does the same.

§ 535. Another general principle which I have already alluded to, is of so much importance in the intellectual and moral philosophy of man, that it requires to be more extensively explained and illustrated.—I have said (§ 575.) that the sensations of perception, both in their primary form, as reproduced by conception, and in the form of thoughts of reflection, are intimately associated with our feelings or emotions, so that, the perception—the conception and even the thought of certain things

will produce certain emotions; and on the other hand, certain feelings will excite certain thoughts and conceptions by which the feelings or emotions will be very greatly increased. Thus—to repeat the former illustration, (§ 575.) a zealously religious person who always contemplates the favor of his God with pleasurable emotions, and the withdrawment of that favor with painful feelings, will have a pleasurable train of religious thoughts and conceptions called up, and his hopes brightened, and his faith strengthened by that physiological condition of his body which we call a delightful flow of the animal spirits, (§ 305.) whether produced by mental, moral or physical stimuli; and he will consider the feeling as entirely of a religious and spiritual origin and character, and this feeling will be very greatly enhanced by the reaction of the thoughts and conceptions which it excites:—and on the other hand, a physiological depression, by whatever cause produced, will be sure to call up in his mind a train of gloomy thoughts and conceptions, which will exceedingly augment his depression, and he will be filled with religious doubts and fears:—his faith will become feeble and his hopes will be darkened and perhaps yield to despair, and he will attribute the whole of his distress to the doubts and fears of his mind, and these, he will attribute to his convictions of his very great sinfulness, and the total withdrawment of the favor of his God.—He will, at such times, review his past life with the deepest anguish and remorse, and contemplate many former deeds as unpardonably sinful, which, in a healthier state of his nervous system, he regards in a very different light:—and the darkness of his doubts, the depth of his despair, and the violence of his remorse will always be proportionate to the morbid irritation and physiological

depression of his nervous system.—The unhappy Cowper affords a melancholy illustration of this doctrine.

§ 586. It is then, a general law of the mind, which governs it in all states and conditions, that the importance, in our estimation, of any subject which we contemplate, or the force of any evidence which we examine, is always equal to the degree of feeling or emotion connected with our thoughts, conceptions and perceptions on the subject, and consequently our reasonings and conclusions correspond with our feelings. But, as we have seen, (§ 305.) the mind cannot be conscious of the difference between those feelings which arise from a peculiar physiological condition of the nervous system, and which cause our melancholy or pleasing thoughts and conceptions, and those feelings which are caused entirely by our thoughts, conceptions and perceptions; and therefore, when the mind acts according to its own consciousness, it always and necessarily judges that all our emotions or feelings connected with our thoughts, conceptions and perceptions, are entirely caused by those thoughts, conceptions and perceptions.—And hence, unless we go out of ourselves, and judge of ourselves scientifically, and independently of our own consciousness, we necessarily attribute to the subject on which our mind is exercised, the influence or power, by which all our intellectual operations and our feelings in regard to it are produced;—and therefore, we necessarily estimate the reality and importance of that subject, to us, by the degree of our feelings when contemplating it, whether those feelings are actually produced by the contemplation, by physical stimuli or by morbid irritation and sympathy.—Thus, when a person is in perfect health of body, he may hear of some expressions of disapprobation which have been made concerning himself, and regard them as a part of the

common gossiping of society; and contemplate them with little or no emotion: but let the same person hear the same things when he is laboring under extreme nervous irritation and depression, and he will contemplate them with great emotion; and all the morbid sensibilities of his nervous system, while they excessively increase the vividness of his conceptions (§ 568.) and the energy of his thoughts, on the subject, will, at the same time, be so intimately connected, and indeed, identified in his consciousness, with his purely mental operations, that he will—without the least suspicion to the contrary, regard them as entirely the result of his mental action on that particular subject,—and therefore, of necessity, in the constitutional nature of things, he will *feel* the subject to be of very great and pressing importance to him, and he will inevitably *judge* its importance to be equal to the degree of the feeling with which he contemplates it. Under this morbid influence of his nervous system upon his mental operations, he will be very likely to think that his reputation is seriously assailed, and to cherish the most painful apprehensions that his character will be ruined, and all his respectability and prosperity and comfort in life, destroyed. The more he contemplates the subject, the more vividly and energetically will his morbid sensibilities call up his conceptions and reflections, which will react upon those very sensibilities, to enhance them exceedingly, and augment the nervous irritation, and fearfully increase the physiological depression and derangement of his whole system: and all this again, will react upon his mental faculties; controlling his mental operations, and forcing upon him the consciousness and the conclusion that all his suffering arises from the ruin of his character, by the malicious calumny of his heartless and wicked persecutors:—and he may soon come to

believe that every body is an enemy, and that, there is a general conspiracy to destroy him.—At the same time, he will be capable of thinking, reasoning and judging, with perfect correctness on any other subject, by which his morbid sensibilities are not excited;—unless his nervous irritation and depression is continually kept up by some physical cause: (§ 581.) and then, he will either manifest equal insanity on all subjects, or it will be exceedingly difficult to draw his attention for a moment from the conceptions and reflections which engross his mind on the one subject; and he will constantly recur to that subject, as soon as the direct efforts cease, which are made to fix his attention on real perceptions.

§ 587. The same important law of the mind is illustrated by a case of inebriation. A person who is under the intoxicating effects of tea, coffee, tobacco, opium, wine, distilled spirit, or any other narcotic or alcoholic substance, is like an organ filled with wind, which is ready and pressing to rush out and form a tone, at any pipe which is unstopped. He is filled with a nervous pathos which is ready to manifest itself in the form of a moral passion, at any pipe of the mind which may be opened to give it vent. Or in other words, he is under a nervous excitement which becomes identified with the exercises of the mind, on any subject to which his attention may be called; and causes him to think, conceive, perceive, feel and act on that subject with an ardor and earnestness commensurate with its intensity. If he be engaged in religious meditations or exercises, all his nervous excitement produced by the intoxicating substance, will become to his consciousness, purely religious feeling arising from the action of his mind on the subject which engages his attention: (§ 586.) or perhaps he will even attribute it to Divine influence, and he will rejoice in the blessedness

of his frame of mind and tenderness of heart, and he will sing, exhort or pray with a self-satisfaction equal to the tone of his feelings, and perhaps with a pathos of eloquence which will stir up the sympathies of all around him. While in this state, he necessarily judges according to his feelings: religion is then every thing to him,—he marvels that every body should not be religious,—this world with all its joys and promises and hopes is a mere delusion, and he is ready, yea, longs to shake off his earthly tabernacle, and hasten to the mansions of the blessed. But when his stimulation has passed away, it is possible you may find him of a very different tone and complexion of piety.—If he be engaged in convivial pleasures, surrounded by cheerful companions and music and dancing, all his nervous excitement produced by the intoxicating substance, will become to his consciousness, identified with his mental exercises on every subject to which his attention is directed, (§ 586.)—If he listens to the music, he will feel that it moves him exceedingly, and think he never heard it sound better.—If he becomes attentive to the ladies, he will feel that they never appeared so bright and beautiful and fascinating:—the civilities and courtesies of the gentlemen, will be regarded as uncommonly generous and agreeable.—Or if he thinks himself slighted or insulted, he feels the indignity with equal intensity; and the more he contemplates it, the more his wrath kindles; and in all the degrees of his passion, he judges that his feelings are produced entirely by the insult, and necessarily measures the importance and offensiveness of the insult by the intensity of his feelings: and he vents himself in violent language, or seeks revenge by physical force; and with fists, clubs, dirks, pistols or some other weapon, rushes in his madness to

deeds of violence and outrage, and perhaps of blood and murder.

§ 588. Thus in all circumstances, the nervous excitement produced by an intoxicating substance, is naturally converted into a moral affection, emotion or passion, on any subject to which the attention of the mind is given, and, in the consciousness of the individual, becomes purely the effect of his perceptions, conceptions and reflections on the subject which occupies his attention; (§ 586.) and this affection or passion, with all the augmentation which it may receive from the mental perceptions, conceptions and reflections, necessarily governs the conclusions or judgment of the mind, in regard to the importance or character of the subject contemplated. And this is strictly true of all other general nervous excitements, irritations and depressions, by whatever cause produced.

§ 589. Hence therefore, so far as this general law of the mind is concerned, strict mental and moral sanity requires that the degree of our propensities, affections, emotions or passions, on every subject upon which the mind acts, should be exactly equal to the relative importance of the subject contemplated, when accurately compared with all other subjects, and things which exist, or of which we ever have any notion:—or should precisely correspond with what is really true in the nature of things. All departure from this, is a commensurate deviation from strict mental and moral sanity. He that desires, loves, hates, abhors, or in any manner estimates any thing above or below its real worth, is in some degree insane.

§ 590. This is one of the most important general laws of the mind: and the almost universal disregard of it in the education of children and youth, is the source of immense evil to mankind. It requires that in our early education, our affections should receive the utmost attention,

and that, every possible precaution, pains, and measure should be taken to prevent the association of an improper degree of affection or feeling with any of our perceptions, conceptions or reflections: (§ 575.) that when we think of supplying any of the real wants of the body and when we think of labor, pleasure, poverty, riches, dress, splendor, fame, time, eternity, life, death, virtue, vice, or any thing else, our affection should always correspond precisely with the real importance of the thing contemplated, and thereby enable us to estimate each and every thing at its true value, and thus preserve a strict mental and moral and religious sanity.

§ 591. Now then, if we bring together the important principles which have been explained and illustrated, we shall see the philosophy of insanity, and find that even in the worst kinds of madness, the mind is still strictly true to the same general laws that always govern the human mind in all conditions. (§ 559.) In the first place, we have seen (§ 561.) that, perception consists in the impression or sensation received, by the centre of animal perception, (§ 280.) from the action of the visual, auditory, olfactory, gustatory and tangible properties of external things, on our organs of sight, hearing, smell, taste and touch, and from the affections which arise from the internal wants and conditions of the body: (§ 560.) and that, conception, (§ 568.) consists in the distinct and vivid reproduction of the sensation of perception, without the real action of the properties by which it was first produced; and that, the sensations of perception, (§ 569.) being reflected to the intellectual faculties, form the thoughts of reflection, which are reproduced in what we call memory. (§ 572.) We have seen, in the second place, (§ 574.) that the succession or order in which our perceptions, conceptions, and reflections take place, establishes an association

between them, so that certain perceptions, or conceptions, will call up certain thoughts of reflection,—and certain thoughts of reflection may produce mental conception: also, our propensities, feelings, emotions and passions are so associated with our perceptions, conceptions, and thoughts of reflection, (§ 575.) that our perceptions, conceptions and reflections will call up our appetites, emotions and passions, and these, in return, will call up our reflections and conceptions. But, though the law of association is an essential and permanent principle in our mental operations, yet the particular associations of our thoughts and feelings, may, and do continually undergo changes. Our particular perceptions, conceptions, reflections and emotions are, at different times, and in different conditions, attended with very different associations. We have seen, in the third place, (§ 576.) that a distinct, vivid and complete perception and conception cannot take place at one and the same instant:—though the mind may sometimes, in a measure, imperfectly attend to both at the same instant: or in other words, we may have imperfect visual conceptions and auditory, olfactory, gustatory, or tangible perceptions at the same time, in a relaxed state of the mind. But when we have a distinct and perfect visual perception, we cannot have a visual conception at the same instant, and when we have a distinct, vivid and complete visual conception we cannot have a visual perception, in the slightest degree, at the same instant. Thus, when a person has a distinct visual perception of a post, or stump, he can have no visual conception at the same instant: but if he is excessively afraid of meeting and being killed by an Indian, his fears may produce a distinct, vivid and complete conception of an Indian, occupying the place of the post, but the instant the conception takes place, his perception is lost,

and while the conception continues perfect, he can no more see the post nor any thing else, than a blind man, and the Indian which he conceives, is as much a reality to his mind as the post was which he perceived: and therefore, it is a general law of the mind, which governs it in all states and conditions, that our conceptions, when distinct, vivid and complete, are as much realities to the mind, while they last, as our actual perceptions, and that the mind cannot possibly know them from realities until they have ceased to be. (§ 578.) We have seen in the fourth place, (§ 575.) that all general nervous irritations, excitements and depressions, by whatever cause produced, call up reflections and conceptions of the mind, and are attended with feelings which become identified, in our consciousness, with our mental operations; and are greatly augmented by our reflections and conceptions:—the degree of intensity always bearing a relation to the irritability of the nervous system. And the mind, we have seen, (§ 305.) cannot of its own consciousness, discriminate between those feelings which arise from a peculiar condition of the nervous system, and which cause our pleasing or melancholy thoughts and conceptions, and those feelings which are caused entirely by our thoughts, conceptions and perceptions; and therefore, when the mind acts according to its own consciousness, it always and necessarily judges that all our emotions connected with our thoughts and conceptions and perceptions, are entirely caused by those thoughts, conceptions and perceptions; and hence, we necessarily attribute to the subject on which our mind is exercised, the influence or power, by which all our intellectual operations and our feelings in regard to it, are produced: (§ 585.) and therefore, we necessarily estimate the character, and the importance of that subject to us, by the degree of our feel-

ings when contemplating it. It is therefore, a general law of the mind which governs it in all states and conditions, that the importance, in our estimation, of any subject or thing which we perceive or contemplate, is always equal to the degree of feeling, emotion, or passion, connected with our perceptions, conceptions and reflections on the subject; (§ 586.) and consequently, our reasonings and conclusions, or judgment, always necessarily correspond with our feelings.

§ 592. If then, an individual is laboring under a general nervous irritation by which distinct and vivid conceptions are continually produced, the morbid sensibilities developed by that irritation, and excessively augmented by the reaction of the excited mental operations, will greatly increase the vividness and energy of his conceptions and reflections, and at the same time, necessarily cause him to estimate the importance of the subjects and things contemplated, according to the degree of feeling which attends his mental operations. Continual conceptions will therefore not only take the place of perceptions, and become realities to his mind, but his conceptions and reflections will be attended with a degree of feeling which will make the things contemplated of the most absorbing interest and pressing importance to him.—New associations of thoughts, conceptions, perceptions and emotions will soon be formed, which will aggravate and perpetuate the unhappy state of things; and if the individual be not speedily restored to health, permanent intellectual and moral habitudes will necessarily be established.

§ 593. If the nervous irritation and excitement be very great, total insanity and raving madness will be the result. But if by slow degrees, the continued or frequently repeated action of irritating causes, has developed a general morbid irritability, rendering the nervous system

extremely excitable, without keeping up a permanent irritation or excitement, then the individual will manifest sanity or insanity according as his nervous system is composed or excited. In this situation, some individuals are, when not excited, equally sane on all subjects, and when excited, equally insane on all subjects. Others, from some cause or other not difficult to explain, will, while under nervous depression, fix the mind on some particular subject, and associate their morbid sensibilities with it, and necessarily estimate it according to the character and degree of those sensibilities, till it becomes of absorbing interest to them, (§ 305.) and all the reasonings, conclusions, conceptions, reflections and associations of the mind, obey the controlling energy of that interest. These, when the nervous irritation is subdued, will be perfectly sane, but the moment they are excited by any means, the morbid sensibilities developed by the excitement, being intimately associated with that particular subject, will instantly call up the thoughts and conceptions of the mind on that subject, and they will manifest insanity on that subject alone. But though they manifest insanity only on one subject, it is almost impossible, while they are under that nervous irritation which causes them to manifest the monomania, to fix their attention for an instant on any other subject, because their morbid sensibilities continually cling to the associated thoughts and conceptions, and drag them back, as by an irresistible instinct, to the all-absorbing subject. And in many instances, this subject becomes of such thrilling interest to the mind, that the bare naming or suggestion of it, will instantly produce a general nervous irritation, developing the morbid sensibilities, and all the manifestations of monomania; and finally, the associations become so exten-

sive that every thing external and internal constantly suggests the absorbing subject.

§ 594. We see therefore that, in all species of insanity—even the worst cases of madness, the mind is true to the laws (§ 559.) which govern it in all states and conditions; and that the body alone is at fault, in the morbid irritability, excitements, depressions and sensibilities of the nervous system; by which thoughts and conceptions of an improper kind are continually called up, and the subjects on which the mind acts are made of undue importance; and new associations and combinations of ideas are formed, and new associations of thoughts and feelings are established.

§ 595. Now the question is, whether according to phrenology, the brain is the special seat of this nervous irritation, and monomania is owing to a morbid condition of a single cerebral organ, or whether the morbid irritability and irritation are common to the whole nervous system and especially the nerves of organic life, (§ 228.) and monomania and other species of insanity are results of that irritation according to the laws which I have explained?

§ 596. I confess that I am decidedly in favor of the latter opinion, for many more reasons than I can assign at this time.—I will however adduce a few of them.—In the first place, there is not a portion of the brain nor of the little brain which has not frequently been destroyed in different individuals, without the least manifestation of mental derangement,—either particular or general. I well know the reply;—that, the organs are double,—and one eye may be destroyed without destroying vision, &c.; but this argument, even if it be tenable, does not meet my position. It may answer on the question of the plurality of the cerebral organs, but not on that of monomania, as caused by the local disease of a particular cerebral organ.

In the second place, pistol and musket balls have been shot into the brain;—swords, tomahawks, and other instruments have been struck into the brain in various directions, and in some instances so as to wound corresponding parts of both hemispheres at the same time; portions of the brain have been discharged at the wounds of the skull.—Surgeons' fingers and instruments have been thrust deep into the lobes of the brain,—and all this has repeatedly taken place without the slightest manifestation of particular or general insanity.—In the third place, there is no evidence either from post mortem examinations or any other pathological facts that either general or particular insanity, was ever caused by the disease of a particular part of the brain which was strictly local, or which did not involve the whole brain in its irritations.—On the contrary, all that we know on the subject goes decidedly to prove that, when diseases of the brain, whether caused by external violence or internal disturbances, are strictly local—when all the morbid affections are confined to the particular part diseased, no manifestations of mental insanity either general or particular, ever take place. And it incomparably more frequently happens that post mortem examination discloses local disease, change of structure, and total destruction of particular parts of the brain, where there has been no manifestation of mental insanity during life, than where there has:—and I contend that, when any degree of insanity has attended local disease of the brain, *that* disease has involved the whole brain, at least, and probably all the nerves of organic life in its irritations: and I can scarcely doubt that, in most cases of this kind, the local disease itself, instead of being the cause of the insanity, is only an effect of the same cause that produces the insanity. I am also confident that the brains of fifty or

any other number of those who have terminated life after many years of chronic mania either general or particular, will, in the average, exhibit as healthy an appearance, as the brains of an equal number of persons who have terminated life after suffering for an equal number of years, under any other form of chronic disease, which involves the nervous system of organic life, in an equal extent of physiological derangement.—In the fourth place, both general and particular insanity often, if not generally, result from irritations which have their special seat in the domain of organic life, and perhaps most frequently, in the digestive organs. I once attended the dissection of the body of a hospital patient, who, according to the opinion of his attending physician,—a distinguished medical gentleman,—died of religious mania. His mind had been totally deranged, and his madness was at times so violent that it was found necessary to confine him; but the single subject which constantly occupied his mind was religion, and therefore his case was pronounced religious mania.—A number of medical gentlemen and students were present at the dissection, and it was observed by all that the subject was depressed at those parts of the head, where phrenologists have located veneration, marvellousness and conscientiousness. On examining the subject internally, not the slightest trace of disease could be found till we discovered an *intus susception* of the small intestine, attended with indications of a high degree of inflammation before death, which extended over a considerable portion of the jejunum and duodenum.—The subject was very recent, so that no important post mortem changes could have taken place; and there was nothing to afford us the least ground of doubt that, both the mental mania and the death of the body had been caused by the disease seated in the small intestine.

§ 597. The following is a brief abstract of an interesting statement given me by an able practising physician.—“D. C. M., a well-digger—33 years old—full habits—was attacked with a relax on Monday, Sept. 16, while at labor in a well, but continued labor.—Tuesday at noon—appetite poor—took little for his dinner beside pickled cucumbers, —nd went to his labor;—relax increased, attended with spasms in the muscles of the abdomen and lower limbs and some pain in the region of the stomach.—At eight o’clock P. M. I was called—found him vomiting and purging with spasms—bled him freely—spasms relieved—ordered warm water and a cathartic;—he threw up the pickles—cathartic operated—after which he took an anodyne draught and rested quietly during night.—Wednesday he was relieved—some soreness remaining over the stomach—I ordered gruel for diet and left him.—Thursday he felt perfectly well, and notwithstanding my strict prohibition and his wife’s remonstrances, he ate a hearty dinner of flesh with some pickled cucumbers, and went into his garden.—In about one hour, returned perfectly delirious; and left home for the village where he wandered about till near six o’clock P. M., when he was got home.—His delirium all this time had been continually increasing. Two persons were sent in haste to call me, but not finding me at home, one of them called in Dr. W.—When I arrived Dr. W. was bleeding him, under the impression that he was laboring under phrenitis. On inquiry I learned from his wife what he had done and that he was quite well at noon before he ate his dinner: and I told Dr. W. that I suspected the cause of the delirium to be in the stomach or bowels.—He thought it was in the head,—but as he considered the patient mine he left him to me and withdrew.—I immediately directed measures to evacuate his stomach and

bowels.—His symptoms had been very little relieved by the bleeding, although it was copious—say thirty ounces—and there was no symptom present to indicate any derangement of the chylopoietic viscera. On making pressure however, over the stomach, he flinched: and on drinking a glass of cold water he manifested uneasiness at the stomach. There was no suffusion of his face and eyes with blood—his eyes were brilliant and their whites of a pearly whiteness—their expression mild and playful. His thirst was incessant.—He would not suffer me to examine his tongue. An emetico-cathartic was administered which operated several times.—Not being satisfied with the catharsis, I ordered castor-oil,—supposing from the account given by the attendants that the emesis had been quite sufficient to evacuate the contents of his stomach at least;—for they said he had vomited four or five times severely. At ten in the evening his bowels had been moved seven or eight times, and he had vomited about the same number of times: but his delirium was not relieved. He had thrown up a little of what his attendants supposed to be a part of his dinner:—and was still a little sick at the stomach. Warm water was ordered to be taken freely, which brought on full vomiting again. After several severe efforts he threw up a mass of what proved on inspection to be flesh and pickled cucumbers.—From that moment his delirium ceased and he immediately recovered.”—This medical gentleman is a full believer in phrenology.

§ 598. I might add numerous cases of this kind, many of which have fallen under my own observation:—but I deem it unnecessary.—Puerperal insanity most unquestionably results from irritations located in the domain of organic life, and involving the whole nervous system.—In short, I fully believe that, at least, ninety-

nine cases in a hundred of chronic mania, originate in the irritations of the nerves of organic life, and that, when cerebral disease or change of structure supervenes, it is the result of the same cause that produces the mania, and is preceded by manifestations of mental insanity.—I do not think therefore, that monomania, in any degree, proves a plurality of organs in the brain.* Yet I freely admit that, all my reasoning being true, there may still be a plurality of cerebral organs,—and I do not affirm that there is not:—but I contend that it is a matter, which yet requires proof:—and whether true or not, the phrenologists have evidently made the contents of the skull too exclusively the machinery and source of the mental and moral powers and animal propensities.

§ 599. The brain, whether consisting of a single organ, or of a system of organs, is unquestionably the seat of intellect, (§ 260.) but it is not equally evident that it is the seat of all the animal propensities:—though it is possible that each propensity has its special organ of perception in the brain. We know that if the nervous communication between the stomach and the centre of animal perception be cut off, the animal can have no perception of hunger; and it is very certain that hunger is a special sense (§ 560.) produced by a peculiar physiological condition of the nervous tissue of the stomach and perceived by the animal centre; but neither the hemispheres of the brain nor the lobes of the little brain, are essential to the animal perception of hunger or desire for food. (§ 259.)

§ 600. We are told that some men can *feel* the exer-

* If the views I have presented be correct, then monomania, as well as other kinds of insanity, should be regarded and treated as a symptom of general morbid irritability, sensibility and sympathy, rather than as a local disease of a particular portion of the brain.

cises of particular parts of their brain in their mental operations:—but I leave those to believe such things who can;—and I ask if ever any one felt his brain to be the seat of his propensities and emotions? Have not mankind in all ages, from mere feeling or consciousness, always referred these emotions to the epigastric region? What lover, or parent, or patriot, in the gush of his emotions, ever instinctively laid his hand on the back of his head and spoke of the ardor of his feelings? (§ 544. Nos. 4. 5. 7.) But shall I be asked if I intend to affirm or imply that the mind has one seat and the propensities and sentiments another, and that the abdominal viscera (§ 313.) have an independent power of sensibility within themselves and constitute the special organism of the animal propensities and moral sentiments?—I reply that, I mean simply to affirm that, there is a oneness in the nervous system of the human body:—that to a certain extent and for certain purposes, the nerves of organic, and of animal life constitute a single whole, and that the point of unity or centre of perception of this single whole, is at, or near the top of the medulla oblongata. (§ 280.) In the domain of organic life, we have seen, (§ 219.) that there are special centres for special purposes, and a common centre (§ 218.) which presides over the whole internal economy: and so far as the wants of the vital economy require the exercise of voluntary functions, the animal centre has a perception of those wants. (§ 294.) Or in other words: the vital economy manifests those wants by producing certain physiological conditions of the tissues of certain organs in its organic domain; and the animal centre, by means of nervous connexions established for the purpose, perceives those physiological conditions, and thus they become special senses; and as strictly so as sight, hearing, smell, taste and touch.

(§ 560.) The animal centre then as a unit, does, as it were, throw out its feelers into every portion of the body internally and externally. By the internal feelers it perceives those physiological conditions of the organic domain, which being perceived, constitute the sense of hunger, thirst, &c.; and thus it has cognizance of all those internal conditions which directly relate to the voluntary powers.—By its external feelers it perceives those impressions made by the qualities of external things, which constitute the senses of touch, taste, smell, hearing and vision:—and thus we are enabled to perceive both our internal wants and the external supplies. The perceptions of the animal centre are all instantly reflected to the intellectual organ or organs and produce thoughts of reflection in the manner I have described. (§ 569.) Moreover, as we have seen, the brain and all the nerves of animal life continually and entirely depend on the functional integrity of the nerves of organic life for their own functional powers; (§ 209. 260.) and therefore, though we have no special sense of perception by which we are informed of all the functional aberrations in the domain of organic life, yet the brain always sympathizing in the general conditions of that domain, we are conscious of the effect without knowing the source. (§ 305.)

§ 601. On the whole then, though I do not wish to be considered as an opposer of the theory of Dr. Gall, but am strongly disposed to favor its general principles, (§ 553.) yet I must contend that while the brain either as a single organ, or as a system of organs, is the special seat of thought, the whole nervous system is so intimately connected with the brain as its intellectual and moral instruments, (§ 600.) and the intellectual and moral operations of the brain are so closely associated (§ 575.)

with the conditions and influences of the nerves of organic life, (§ 305.) that the intellectual and moral philosophy of man cannot be accurately understood, without a just knowledge of the nervous system as a whole;—and that the physiological laws with their important relations constitutionally established in the organic domain, are of incomparably more importance to the philosopher, the philanthropist and the Christian than the external shape of the skull or even the internal structure of the brain. For, admitting all that phrenology claims, in regard to cerebral organization, it is still true that the intellectual and moral character of man, can only be constitutionally reached through the medium of the nerves of organic life: (§ 306.)—or in other words, it is only by a proper attention to the physiological laws of the domain of organic life, that we can justly hope to have such an effect on the shape and condition of the brain, and other parts of the body, as will secure health, wisdom, virtue, and happiness to the human race.

§ 602. My apprehension is that, the intellectual and moral science of man, is far more profound and intricate than phrenology contemplates, and cannot be fully understood without a knowledge of all the properties and powers of the whole human system: and therefore instead of limiting our observations and investigations to the head in order to find out what a man *is*, we should extend them over the whole organization and endeavor to ascertain the particular and the general laws of animal, intellectual and moral physiology, that we may not only know what man *is*, but also what he ought to be, and how to make, and keep him so.

LECTURE X.

General Law of relation between the instincts and the voluntary powers

—Brute reason—General law of relation between the instincts and cerebral faculties—Man and animals under the same law—But man can deprave himself and multiply his wants—Not so other animals—Artificial wants of man act on his cerebral organs the same as the natural wants—Man's superior intellect sinks him deeper in depravity—What he would be without moral powers—The end for which his moral powers are established—These, his distinguishing and most exalting attributes—Relations of man to his Creator and to his fellow creatures—The Gospel agrees with physiology—The moral probation of man—His moral ability and inability—Conscience, what?—Moral sense innate—Its power—A false or true conscience, how formed—Moral sense more or less active, and powerful—Effect of morbid sensibility of the nervous system on the moral sense and conscience—False conscience, its sources—Man naturally and necessarily religious—Superstition, bigotry, fanaticism—Man's moral responsibility—Other moral faculties under the same laws.

§ 603. WE have seen that the nerves of organic life preside over all the functions concerned in the nourishment, growth and general sustenance of the body; (§ 223. 227. 228.) and that so far as digestion, absorption, respiration, circulation, secretion, excretion, organization, the regulation of temperature, &c. are considered, the animal, like the vegetable, is, in a state of health, destitute of consciousness; (§ 203.)—and, could the animal like the vegetable be regularly supplied with nourishment without the exercise of voluntary powers, the animal

body, like the plant, might be developed—attain to its full size—live out its constitutional period, and die and decay without the least consciousness of its existence. (§ 294.)

§ 604. But the animal body is constituted with such relations to the external world, as require the exercise of voluntary powers, to supply the wants of its internal economy. (§ 209.) Hence it is furnished with an apparatus of nerves and organs adapted to its external relations. (§ 283.) This apparatus (§ 233.) consists of the nerves of animal life, which are endowed with peculiar properties and powers (§ 294.) by which the animal is made conscious of its existence, and enabled to perceive its internal wants, and those external properties and things, by which its wants are supplied, (§ 209.)—and of the muscles and bones employed in voluntary motion, by which it is enabled to approach and seize those things which it perceives and wants. (§ 233.)

§ 605. The internal wants, I have said, (§ 600.) are attended with certain physiological conditions of the organs, and these conditions being perceived by the centre of animal perception (§ 280.) become the special senses of hunger, thirst, &c. (§ 599.)—In the lowest orders of animals (§ 209.) the animal consciousness is extremely feeble, and the animal perceptions and voluntary functions are purely instinctive and rudimental. The animal is scarcely elevated above the vegetable. (§ 209.)—As we ascend the scale of animal existence, we find animal consciousness and perception more and more vivid and powerful, and the voluntary faculties more and more developed and active. But from the lowest to the highest orders of animals, including man, it is a universal law of the animal kingdom, that the domain of organic life manifests its wants to the centre of animal perception, in such

a manner as to produce a strong propensity in the animal to exercise its voluntary powers for the supply of those wants.—These propensities are called *INSTINCTS*.

§ 606. In many of the lower orders of animals, the voluntary powers are purely the instruments of the animal instincts.—Without an act of reasoning or of reflection, the animal is moved by the sense of its wants, to exercise its voluntary powers in such a manner as to satisfy the propensity, and in obeying its internal instinct, it instinctively employs its instinctive powers of external relation, connected with its voluntary powers, and by smell, taste and other perceptive senses, feels out the substances adapted to its wants, and thus fulfils the final causes of its organization.—The voluntary powers of the higher orders of animals, are equally obedient to the instinctive wants or propensities, but their exercise is attended with something more of thought and reasoning.—The rudiments of brute reason are probably to be found in all the vertebrated animals;—but they are more and more developed as we ascend the scale, towards man. And there is little ground of doubt that the reasoning powers of animals bear a precise relation, as to their extent, to the developments of the brain.—The monkey tribes, the elephant, the dog, the fox, the horse, the swine and several other animals, give the most unquestionable evidences of their powers of reason and reflection. Nevertheless, whatever be the extent of the powers of brute reason in animals, those powers are always perfectly subservient to the instinctive wants of the body. All the reasoning and reflection ever manifested by the horse, dog, elephant, &c. are excited by their instinctive propensities, and are only exercised in conformity to those propensities, or for the purpose of gratifying them:—and never for the purpose of resisting or restraining them.—

It is therefore a general law of the animal kingdom, that the cerebral faculties, whatever they may be, are subservient to the wants of the body:—and all the intellectual and voluntary powers naturally concur with the animal propensities and seek their gratification.

§ 607. It is, as I have stated, (§ 530.) entirely certain that, whatever be the substratum of the sensorial power of the human brain, it resides in, and acts through the organized matter of the nervous substance, during our present state of existence, precisely the same as if it were merely a property of that vitalized matter, and all its powers and manifestations are subject to precisely the same laws as govern the powers and manifestations of vitality. Hence, so far as the instinctive wants and animal propensities, and their relation to, and influence upon the intellectual and voluntary powers, are considered, man is in the same general predicament with the lower animals:—all his internal wants, and propensities, appeal to his intellectual and voluntary faculties, and excite their action, and naturally cause them to concur with, and seek the satisfaction of the bodily desires. And, although there is an almost infinite distance between the reason of man and that of the highest order of the lower animals, yet the philosophy of his reasoning is precisely the same as that of the elephant, the horse, &c., and consequently it is governed by the same general laws. But man's superior intellectual and voluntary powers not only increase his ability to supply his bodily wants in all the varying circumstances of seasons and conditions, but also increase his power of multiplying those wants, by his artificial modes of supplying them, and by the artificial circumstances of social and civic life.

§ 603. The horse and ox and other animals, like man, have the special sense of thirst, or natural want of water,

but they have neither the reasoning nor the voluntary powers to supply this want with any thing else but water, and therefore, from birth to death and from generation to generation, they only feel the same natural and simple want, and are always satisfied when that want is supplied with good water; but out of this simple and single want of his body, man generates a thousand artificial wants, which become ingrafted upon his body and exert their influence upon his intellectual and voluntary powers in precisely the same manner as his original instinctive wants do, and always with a more despotic and imperious energy; and with a continual and powerful tendency to excess. The same is true of the special sense of hunger: in the lower animals, it is always equally simple and natural unless depraved by the artificial training of man; but man multiplies this simple, natural want into a thousand artificial ones, which exert a controlling and arbitrary influence upon his intellectual and voluntary powers:—and in the same manner, every other natural want and sense of the human body, are multiplied by man to the extent of his capabilities; (§ 21.)—and out of these innumerable wants which are ingrafted upon the natural propensities and sensibilities of his body, spring a multitude of others, in connexion with the social and civil institutions and customs of society. These thousands of artificial wants soon come to be so intimately and completely associated with the natural wants of the body, that few know the difference between the natural and the artificial: and all of them, with different degrees of energy and despotism, press their demands upon the intellectual and voluntary powers, urging or compelling those decisions of the mind, and those exercises of the voluntary powers, by which they can be satisfied or indulged:—and upon precisely the same principles of intellectual and moral philosophy as govern the

action of the original instinctive wants of the body, upon the cerebral faculties. (§ 575. 586.)

§ 609. But in thus multiplying his wants, man necessarily, not only depraves the natural instincts, propensities and sensibilities of his body, and increases the force and despotism of his wants upon his intellectual and voluntary powers, but he also, impairs his mental faculties, and deteriorates his whole nature, and tends to the destruction of mind and body.

§ 610. Hence therefore, were man only elevated above the other animals by superior intellectual and voluntary powers, his natural elevation would answer no other end than to increase the distance of his fall and the depth of his degradation and misery. He would, indeed, be the vilest and most wretched of all terrestrial things. With all his intellectual and voluntary powers subservient simply to the supply of his bodily wants, and those wants multiplied beyond number, and increased continually in despotism and depravity, his superior powers would only be a superior ability to make himself miserable, and to destroy himself and others. His reasoning powers would be employed with little more than the excitements of his appetites and feelings, and in securing the means of his self-indulgence, and in devising the crafty or the violent measures by which he could procure or destroy whatever his lusts or passions demanded;—his judgment would be but the dictates of his propensities;—desire would constitute his only principle of action; and this would lead him downward, deeper and deeper into the abyss of animal depravity, and subjugate his intellectual powers to more and more degrading and debasing slavery to his sensuality. Never would his reason remonstrate with his passions;—never would his judgment condemn his indulgence: strength would constitute the right of precedence,

and power, the law of possession! and man would prey upon his fellow creatures, with an energy and cruelty, by so much the fiercer and more destructive and terrible than the most ferocious of other animals, as he possessed superior intellectual and voluntary powers to deprave himself, and to devise and carry into execution more crafty and skilful plans of destruction.

§ 611. To prevent this natural tendency of man's animal nature, and to excite his intellectual powers to elevated and extensive efforts in the attainments of knowledge and wisdom, a wise and benevolent Creator has endowed him with MORAL POWERS and made him the subject of moral government.

§ 612. Thus God has created matter and impressed upon it those primary laws (§ 89.) by which it enters into the various forms of the inorganic world, and by which those forms are governed as individual masses:—and upon the common matter of the inorganic world he has superinduced still higher laws of action and constitution, (§ 110.) by which it is made to enter into the arrangements and forms of living organized bodies:—and upon organized matter he has superinduced still higher laws of constitution by which living bodies are endowed with a consciousness of their existence and with the power of perceiving their internal wants, and of perceiving and procuring the external supplies: (§ 114. 138.)—and upon animal consciousness and sensibility he has superinduced still higher laws of constitution by which the animal is endowed with intellectual powers: (§ 165.)—and finally, upon the associated animal nature and intellectual powers of man, God has superinduced moral powers.—It is therefore, the *moral nature* of man which gives him his highest elevation in the scale of being, and places him at the greatest distance from his fellow animals and nearest to angels or to devils.

§ 613. By this wonderful union of intellectual and moral powers with organized matter, man alone, of all terrestrial beings, is brought into a twofold relation to his Creator.—In his material nature, man, in common with all other material forms and substances, holds a fixed relation to his Creator as the great, first, and continually efficient Cause by which matter and all material forms and properties and powers are what they are. This relation only embraces the natural attributes of God.—In his moral nature man holds a fixed relation to his Creator, as an infinitely true and just and benevolent and good and holy Being and Judge and Father. But as there is of necessity, an essential and perfect harmony between the natural and the moral attributes of God, so is there a perfect harmony between the natural and moral relations which man holds to his Creator: so that, the perfect fulfilment of the one requires the perfect fulfilment of the other. That is, the constitutional laws which govern the living, organized body of man, and on which all its physiological properties and powers and interests depend, harmonize most perfectly with the constitutional laws which govern his intellectual and moral nature. So that, the highest and best condition of the human body requires a perfect obedience, not only of its own physiological laws, as living organized matter, but also of the constitutional laws of the intellectual and moral nature associated with it: and the highest and best condition of man's intellectual and moral nature requires the perfect obedience, not only of its own constitutional laws, but also of the constitutional laws of the body as living organized matter:—and consequently, the violation of the constitutional laws of the one, is necessarily attended with an infraction of the constitutional laws of the other. Hence therefore, no moral or civil law or reli-

gious doctrine can be adapted to the highest and best condition of man's moral nature which is not strictly consistent with the physiological laws of his body:—and on the other hand, no bodily habit, indulgence, or regimen can be adapted to the highest and best condition of his body, which is not strictly consistent with the constitutional laws of his intellectual and moral nature. And it is a deeply interesting and incontrovertible fact, worthy of all consideration, that if one who had the most perfect knowledge of the physiological laws of the human body, should draw up a code of moral and religious laws for man, which should in every principle and point be strictly conformable to the constitutional laws of man's bodily and moral nature, and most philosophically adapted to the condition and relations of man, he could not possibly produce a code more wisely fitted to the constitutional truth, and to the highest and best condition of human nature even in this world, than is contained in the New Testament of our Lord and Savior Jesus Christ.

§ 614. The animal nature of man may be considered as the basis of his human existence.—Its passions, its propensities, its desires, with all the artificial wants that are ingrafted upon the bodily instincts and sensibilities, constitute the primary and principal elements of activity to his mental powers, and tend continually to cause his rationality to concur with his animal indulgence, or to consent to, and provide for the gratifications of all his sensual and selfish appetites and desires, both natural and artificial. (§ 608.) And this is what the apostle Paul, who was one of the most profound philosophers that ever lived, calls *the minding of the flesh*; and with equal physiological and moral and religious truth, he declares that the minding of the flesh is death:—for as we have seen, (§ 609.) it inevitably leads, if unrestrained, to the speedy

destruction of the body and of the mental and moral powers, and to the extermination of the race. But the moral powers which God has constitutionally established in human nature, (§ 611.) come in to regulate the carnal nature of man, with reference to moral law, which, as we have seen, (§ 613.) perfectly harmonizes with the physiological laws of man's nature.—And the whole bearing of moral law on human nature, is to hold the carnal passions, propensities and desires, (§ 608.) in perfect subjection to a rationality which is enlightened and governed by moral truth.

§ 615. Moral truth says—thou shalt love that supremely which is intrinsically most excellent and worthy of being loved,—which is the moral character of God,—and which, being supremely loved, will not only secure thy own highest and best condition, but the supreme love of which, in thee, is most perfectly compatible with, and conducive to the highest and best condition of thy fellow creatures:—but carnal nature says—I will love that supremely to which I have the strongest intrinsic propensity, which is self-indulgence.—Here then, is the conflict of man's moral probation:—between his carnal nature, with all its natural and acquired wants and appetites, (§ 608.) and God's moral truth:—for the flesh lusteth against the spirit of truth, and the spirit of truth striveth against the flesh:—and therefore, the minding of the flesh, beyond the true and proper fulfilment of the constitutional laws of human nature—or beyond the true and proper supply of the real wants of the body, is, of necessity in the nature of things, contrary to supreme love to God; for it is not obedience to the laws of God; neither indeed can be: because it is a direct transgression of those laws. (§ 613.)

§ 616. The moral nature of man is established by the

Creator to preside over, and control this conflict, and is made responsible at the bar of God's eternal and immutable truth, for the issue; and necessarily liable to the penalties which result from the infraction of God's laws.—On the one hand, man's carnal nature is continually pressing for indulgence, and exerting its seductive influences on the rational powers, to draw them into concurrence with its propensities and appetites;—while on the other hand, the moral truth of God, which perfectly harmonizes with the natural truth of God (§ 613.) constitutionally established in the physiological laws of the human body, demands of man's moral nature, the entire subjugation of his carnal passions, propensities and appetites to the requirements of moral truth, and declares that he who desireth to transgress, is essentially guilty of the act.

§ 617. The whole controversy of the schools concerning man's moral ability and inability, may therefore be resolved simply to this,—namely, his ability to will and act in obedience to moral truth, subject as his intellectual and moral powers are, to the influences of his carnal nature. (§ 608.)—His moral ability is always precisely equal to the degree in which his moral powers hold his carnal nature in subjection to moral truth:—and his inability is always precisely equal to the degree of influence which his carnal nature exerts upon his intellectual and moral powers, in opposition to moral truth.—The more the intellectual and moral powers of man, are under the control of his carnal nature, the greater is his moral inability to perceive, understand and comply with the requirements of moral truth:—and therefore whatever tends to deprave and multiply the carnal passions, propensities and appetites of man, or, in any degree to excite them and increase their power, does necessarily and

directly increase his moral inability to perceive, understand and comply with the requirements of moral truth, and to obey the constitutional laws of his nature.

§ 618. Let us now recapitulate for a moment, for the purpose of bringing our argument to a focus.—Man, then, has an animal nature with constitutional laws common to the elephant, the horse, the ox and other animals. (§ 605.) He is endowed with voluntary and intellectual powers immeasurably superior to other animals, but established with the same relations to the bodily wants and appetites (§ 605.) and with the same philosophy of action as those of the monkey, the elephant, the dog, &c. (§ 607.) The lower animals have neither the intellectual nor the voluntary powers to violate the constitutional laws of their natures, to any serious extent, and thus deprave themselves, deteriorate their natures and exterminate their species, (§ 608:) and therefore they do not require a knowledge of the constitutional laws of their nature, and of the laws of relation which grow out of them. But man has both the voluntary and intellectual powers and the natural propensity to violate the constitutional laws of his nature, and thus deprave, deteriorate and destroy himself. The good of man as an individual and as a species therefore, requires that he should both know and obey the constitutional laws of his nature: and accordingly God has endowed man with moral powers, (§ 611.) which are constituted with fixed and precise relations to his animal nature on the one hand, and to the moral character of God, on the other:—and the office of these moral powers is to prompt man to know and to obey the concordant, constitutional laws of his animal and moral nature, (§ 614.) and thus secure his own highest good and happiness, and promote the highest good and happiness of his fellow creatures, and thereby fulfil

the divine scheme of benevolence which has, in the constitutional nature of things, identified the supreme glory of God with the highest good and happiness of man.

§ 619. To quicken man's moral powers to the faithful and unremitting performance of this important duty, God has from time to time addressed to him such moral instructions, and placed before him such motives, as his moral and intellectual condition fitted him to receive.—In the morning twilight of the intellectual and moral world, when man's moral perceptions were feeble and indistinct, and his knowledge was limited to sensible things, the motives which God placed before him to induce him to know and obey the constitutional laws of his nature, were bodily health, and long life and wordly prosperity and honor. But when God, by the continued operations of his great scheme of benevolence, had prepared the way for the introduction of a higher dispensation of motives, he brought life and immortality to light, and placed before man not only bodily health and long life and happiness in this world, but also moral purity and god-like excellence here, and eternal life and glory beyond the grave, as motives to induce him to know and obey the constitutional laws of his nature.

Now then, let us endeavor to understand the true nature and philosophy of man's moral powers.

§ 620. All mankind are conscious of possessing an attribute or power which, in our language, is called the CONSCIENCE. But theologians, metaphysicians and philosophers have seemed to be quite as much in the dark as the unlearned multitude, concerning the real nature and power of the conscience. Some tell us that, it is that faculty of the soul which discriminates between right and wrong;—or which approves of what is right and disapproves of what is wrong,—so far at least, as to estab-

lish the great lines of demarkation between right and wrong—between vice and virtue. Others, carrying this view still farther, assert that, the conscience is in every breast, an innate rule of right which each individual is bound to obey, and by which, each may measure his own actions; and therefore, that in all matters of conscience, man has a natural and inalienable right to entire and unrestricted liberty.—Others, again, perceiving that the consciences of different persons under different circumstances and with different educations, sanction and enforce things entirely different, and diametrically opposite, are led to believe and assert that, conscience is wholly a result of education, and therefore, no criterion of right, or virtue.

§ 621. But these opinions are all founded on erroneous notions of the nature and powers of man's moral faculties.—Every human being who is not an idiot, and who is old enough to understand the exercises of his own mental and moral powers, has something within him, which, when excited, acts determinately,—and definitely approves or disapproves of specific moral actions and qualities.—This is what all men call Conscience. But this is neither a simple nor an innate power or faculty of the soul:—it is of a complex character, and as such, wholly the result of education;—and is with no degree of certainty, a rule of right.

§ 622. It is not however, more certain that the intellectual faculties of man are innate, than it is that, the MORAL SENSE is an innate power—a constitutional principle in the moral nature of man. But this is not to be confounded with the *conscience*, in correct philosophical reasoning. It is in no degree, the result of education; nor can it be, in any manner, educated, except, in being rendered more or less susceptible, and active and

powerful:—but still, it always necessarily remains the same simple moral sense:—the same in the Pagan, the Jew, the Mahomedan and the Christian!—the same in a Hottentot, a Newton, a Paul!—the same simple moral sense which informs no man what is right or what is wrong: and has no more power than the sense of hunger has, to discriminate, even on the broadest grounds, between right and wrong—between vice and virtue.—It is ever, and under all possible circumstances, the same simple moral sense, out of which grows the consciousness that there is a distinction between right and wrong, and a consciousness of moral responsibility, and, when excited to perform its function, its definite, determinate and only language is—“BE RIGHT!—BE RIGHT!”—but what that right is, it has no power to ascertain. For this, it depends entirely on the intellectual faculties, which collectively, in their mental unity, I call the UNDERSTANDING. Whatever the understanding, acting under the influence of the moral sense, fully determines to be true, or right, the moral sense receives as right; and afterwards, when excited in relation to the same thing, this complex power resulting from the co-operation of the moral sense and understanding, prompts the soul to obey it, as right.—Thus, suppose the proposition be laid before the mind of a man, totally uneducated in morality and religion, and who knows nothing of the customs and opinions of mankind, that it is his moral duty to kill his parents when they become so old and infirm as not to be able to support themselves. His moral sense can neither intuitively nor by any process of reasoning tell him whether the proposition is true or false.—His understanding only can examine and weigh the evidence in the case and come to a conclusion or decision as to the truth or falsity of the proposition. But while

the understanding is doing this, the moral sense can, more or less energetically and continually, exert an influence upon it, which says—"be right!—be right!"—and thus cause the understanding to examine and weigh the evidence in the case, with greater attention, diligence and scrupulosity.—And if by any means, the understanding, acting under this influence of the moral sense, is brought to the full conclusion that the proposition is true, the moral sense has no power in itself to test the accuracy of the conclusion; and therefore, necessarily receives it as true:—and this conclusion, or mixed result of the simultaneous action of the moral sense on the understanding and of the understanding on the proposition, becomes a definite and determinate moral sentiment of the soul, which is so intimately associated with the moral sense, as to be instantly called up as a dictate or determinate impulse of the moral sense, whenever this simple power is excited to action in reference to the same proposition.—And this definite and determinate moral sentiment, is what all men call the conscience.

§ 623. We see then, that in this supposed case, the moral sense of the individual, cannot possibly tell him whether it is right or wrong for him to kill his parents when they become old and helpless. It can only tell him to be right.—But the conscience formed in the manner I have described, (§ 622.) tells him definitely and determinately that it is right and duty for him to kill his parents when they become old and helpless.

§ 624. Now change the circumstances of this individual, and let the same proposition again be presented to his mind, and let his moral feelings be excited on the subject, and all the real evidence in the case presented to him in a true light;—his conscience will come up at once, and say definitely and determinately, "it is right to

kill the parents," &c. But if the new circumstances and new array of evidence, can shake his confidence in the former conclusion of his understanding, and cause him to doubt the correctness of it, the voice of his conscience will become feebler and feebler as the strength of his doubts increases, while the voice of his moral sense, with more and more energy and importunity, will say "be right!—be right!"—and if under this influence of his moral sense, and in view of all the evidence which is now presented to him, his understanding comes fully and confidently to the conclusion that the proposition is false, and that it is wrong to kill his aged and infirm parents,—and right and duty to protect and cherish them, then this conclusion will become a definite and determinate moral sentiment of his soul, taking the place of the former one. And now his conscience will determinately tell him that, it is wrong to kill his aged parents. So that, the conscience of the same individual may at one time tell him it is right—and at another time, that it is wrong to kill his aged and helpless parents.—Yet in all this, the moral sense undergoes no change. Its simple, single, only and unerring cry is always, when excited to action—"be right!—be right!"

§ 625. But the moral sense, I have said, may be cultivated as to the degree of its energy or influence.—And in this respect, its laws are the same as the common physiological laws of the body. It may always be extremely feeble from want of proper exercise, so that, it will never with energy, urge the understanding to ascertain the truth on any point. It may also, be greatly impaired and almost totally obliterated, by the continued violations of the constitutional laws of human nature. (§ 613.) Whatever, in food or drink or any other bodily indulgence or habit, impairs the sensorial power of the ner-

vous system, (§ 607.) commensurately impairs the moral sense; and all intentional violation of the constitutional laws of man's moral nature—every voluntary departure from strict righteousness, truth, holiness, &c. necessarily impairs the moral sense; and when these causes are combined, and their action continued, they often so completely blunt or deaden the moral sense, that the apostle Paul justly compares the effect to the searing of a hot iron.—On the other hand, the moral sense may, by much exercise and careful cultivation, be rendered exceedingly vigorous and active and delicate, so that, it will on all occasions, and in every—even the most inconsiderable moral action and operation of the mind, energetically and healthfully urge the understanding to decide aright,—to act aright.—But the moral sense may also become excessively and morbidly active and acute,—causing the most intense moral suffering, and even producing monomania or general insanity. Whatever in food or drink, or any other bodily habit or indulgence, produces a general morbid irritability and sensibility in the nervous system, (§ 581.) always tends to produce a morbid excess in the moral sense of conscientious people, filling the mind with unhealthy scruples and remorseful anguish and perhaps despair; and sometimes rouses it up in most fearful energy, in those who have never before attended to its wholesome monitions, and fills them with the most terrible remorse and horror! Religious exhortations and appeals, also, which are of an impassioned and terrific character, and which greatly excite the moral sense, without properly enlightening the understanding, always tend to produce a morbid excess in the moral sense, and frequently cause partial or total insanity; and very rarely lead to real and permanent good.

§ 626. When the moral sense is feeble and inactive,

it does not throw a proper degree of influence on the operations of the understanding, but leaves it either to neglect, or carelessly to examine, or unfairly weigh evidences, and thus come to erroneous conclusions, and form a false conscience.—When, on the other hand, the moral sense by any means, is rendered morbidly active and energetic, it throws so vehement and distracting an influence on the understanding, as to impair the accuracy of its operations, and exceedingly weaken or totally destroy its confidence in its own conclusions; and thus the mind is kept in a distressing state of incertitude and perplexity, and conscientious doubt, which only increase the insane energy of the moral sense. And in this manner the keenest and most excruciating excess of human misery is frequently produced.

§ 627. In all cases when a morbid nervous irritation and sensibility attend the exercises of the moral sense, the diseased nervous sensibility becomes identified, in the mental consciousness, with the moral sense, (§ 305. 575.) and thus increases the unhealthy energy of its influence upon the understanding and proportionately increases in the estimation of the mind, the importance of the subject, in reference to which the moral sense is excited. (§ 586.)

§ 628. Having thus ascertained the precise nature and power of the moral sense and of the conscience, and to what extent a want of perfect integrity in the moral sense is conducive to an erroneous or unsound conscience, I proceed to the consideration of other sources of a false conscience.

§ 629. We have seen, (§ 622.) that the moral sense ever and only says, “be right!—be right!”—and has in itself, no power to determine what right is—but depends entirely on the understanding to ascertain what is right;

and whatever the understanding fully determines to be right, when acting under the influence of the moral sense, the moral sense necessarily receives and enforces as right. If therefore, by any means, the understanding is fully brought to an erroneous conclusion on any moral or religious subject, the conscience on that subject necessarily becomes fallacious.—Now there are several sources of erroneous conclusion in the understanding besides those which I have already named.—Much has been said about intuitive knowledge:—but I apprehend there is very little meaning in the term. Except in the perception of our simple ideas, there is always, necessarily more or less of reasoning in every operation and exercise of the mind. (§ 556.) The understanding therefore, always arrives at its conclusions, much as a jury arrive at their verdict. When any subject or proposition is brought before the mind, there must be some evidences for or against the truth of the proposition, and perhaps both.—It is the business of the intellectual faculties to examine these evidences with proper care, and to come to a conclusion in the affirmative or negative of the proposition according to the true force or weight of evidence in the case. But if the true evidence in the case be neglected, or but lightly and carelessly considered, or if but a small part of the true evidence in the case be examined, or if the evidence be unfairly presented, or if false evidence be presented as true, the understanding, even under the promptings of the moral sense, may come to erroneous conclusions, and fully determine that to be true or right, which is not really so, and thus a fallacious conscience will be formed.

§ 630. Furthermore, we have seen (§ 575. 605.) that, the intellectual faculties are constitutionally and intimately associated with the natural instincts, propensities, and

appetites of the body; and that the thousands of artificial wants, propensities and appetites, which are ingrafted upon the natural instincts and sensibilities of the body, act upon the intellectual faculties in precisely the same manner as the natural instincts and propensities do, but with more vehemence and despotism. (§ 608.) We have seen also that, it is a general law, common to man and the lower animals, that the mental and voluntary powers always naturally obey the bodily propensities and appetites, (§ 606. 607.) and seek to supply the bodily wants. Hence all the carnal influences of the human body, and especially those which result from the depravation of the natural instincts and sensibilities, (§ 608.) such as every lust for every kind of intoxicating and every stimulating drink and substance, and every appetite and desire ingrafted upon the body, or growing out of the artificial habits and circumstances of society, are directly adverse to correct perceptions, reasonings and conclusions of the mind on all moral and religious subjects:—and therefore, it is a general law that the ability of the understanding to ascertain moral and religious truth, in view of facts and evidences presented, and accessible to it, always corresponds with the physiological and moral purity of the individual. (§ 617.) Thus suppose a man to be strongly addicted to the use of tobacco, and suppose we should attempt to convince that man that it is morally and naturally wrong to chew tobacco, or use it in any way as a means of sensual gratification. Now in the first place, that man's tobacco has impaired the delicacy of his moral sense. (§ 625.) In the second place, it has in some degree, impaired the nice powers of the understanding to perceive moral truth. (§ 609. In the third place, it has established in the physiological economy of his body, an appetite whose despotic and often irresistible influence

upon the intellectual and voluntary powers, vehemently urges and even absolutely compels the understanding and WILL to comply with its demands. (§ 603.)—When therefore, we attempt to convince him that, it is morally and naturally wrong for him to use tobacco, we shall in the first place, find it extremely difficult to reach his moral sense through the opposing energy of his lust. In the second place, his lust will not suffer his mind to fix its attention seriously and earnestly on the evidence which we present, but will keep it constantly employed in contemplating the importance of the gratification to his happiness, or in seeking for arguments to defend the gratification, or for evasions and subterfuges from the force of our evidence. In the third place, if we succeed in rousing his moral sense, and fixing his attention, and forcing our evidence upon him, his lust will not suffer his understanding to weigh that evidence with impartiality and honesty; but will compel him to weigh it in unequal scales, like one who weighs the gold he receives, in a pair of iron scales with a powerful magnet lying concealed, under the scale which contains his weights, and drawing it down with such a force as to make the gold appear of no weight at all. His lust will not suffer him to measure our evidence by any standard of truth, but force him to measure it by its own despotic and vehement energy, and thus make it appear as nothing. Or if we happen to approach him at a moment when his lust is slumbering in the stupefaction of a recent debauch, or if by any means, we can, for a moment, succeed in silencing his lust, and by the assistance of his excited moral sense, and the force of our evidence, turn the balance of his understanding in favor of truth, and convince him that it is wrong for him to use tobacco, scarcely shall we cease to urge our evidence directly upon his

attention, before his reviving lust will rise up with clamorous and impetuous importunity, or irresistible imperiousness, and bring his understanding to the full conclusion that it is not morally wrong for him to use tobacco,—and thus he will establish a fallacious conscience, and return like a swine to the mire, and like a dog to his vomit.—In this manner, every lust and appetite, natural and ingrafted, (§ 608.) according to the energy of its influence on the intellectual and voluntary powers, tends to produce erroneous conclusions in the understanding, and thus produce an unsound or fallacious conscience.

§ 631. We find therefore, that the carnal influence of the human body on the intellectual and moral powers, (§ 614.) is the grand, primary source of erroneous conclusions and of a fallacious conscience. And this important and incontrovertible principle in mental and moral physiology, is explicitly and fully asserted by the apostle Paul in his Epistle to the Hebrews. He exhorts the Hebrew proselytes to Christianity, to prepare themselves to contemplate and understand and receive and love and obey the simple and pure and sublime doctrines of the Gospel, by having their hearts sprinkled from an evil or unsound conscience:—or, by being cleansed from all those lusts and appetites and prejudices which have led their understandings to erroneous conclusions, and thus established an unsound conscience in them; and unfitted them to receive the Gospel in all its naked and beautiful simplicity of truth.

§ 632. If therefore, by any means, the understanding, under the promptings of the moral sense, is brought to an erroneous conclusion, and fully determines that to be true or right, which is really erroneous or wrong, the moral sense necessarily receives it as true, or right, and prompts the soul to obey it as right; and thus man acts conscien-

tiously wrong.—And this is what Jesus meant when, seeing the Jews acting with great zeal conscientiously wrong, he said to them, “If your eye be unsound, your whole body is full of darkness.”—When an unsound or fallacious conscience is once established it is next to impossible to remove it; especially in any matter which relates to the carnal propensities and appetites. Because the moral sense has in itself, no means of testing the soundness of the conscience, and no way of removing an unsound conscience but by the correct operations and conclusions of the understanding: and the unsound conscience being the advocate of the carnal propensities and appetites which begot it, quiets the moral sense, and prevents its acting on the understanding to excite it to a new examination of evidence and to bring it to new conclusions: and therefore man has, in himself, no disposition to reject that, as erroneous and wrong, which he conscientiously believes to be true and right:—and if others attempt to convince him that it is wrong, his unsound conscience instantly interposes itself between such attempts and his moral sense, and keeps that quiet, while his carnal lusts rise up to prevent the mind from attending to the evidence presented, or to force the understanding to weigh the evidence in unequal scales; and all the while they justify themselves by the unsound conscience which is their offspring:—and hence, as a general rule, it is impossible by any means to remove an unsound conscience until the carnal lusts and inordinate appetites and prejudices are subdued. And it was in view of this great difficulty of removing an unsound conscience, and of the great evils to which such a conscience leads, that Jesus declared to the deluded Jews,—“If therefore, the light which is in you, be darkness, how great is that darkness!”

§ 633. Now, as the condition of the intellectual and moral faculties, and the power of the mind to ascertain the truth—and especially moral and religious truth, greatly depend, as we have seen, (§ 630.) on the conditions of the bodily organs, the more, whatever increases the influences of the propensities, desires and appetites of the body, (§ 617.) on the intellectual and moral faculties, beyond the real and true wants of the human system, not only depraves the organs and leads to all the forms of bodily disease and suffering, and to premature death, but also, necessarily impairs the intellectual and moral faculties—stupefies the moral sense—blunts the perceptive and reflective powers of the mind, and renders man less and less capable of perceiving and appreciating moral and religious truth and of being acted on by any other than sensual motives. Hence the Scriptures declare that the *animal* man receiveth not the things of the spirit of God, because they are insipid or of no force to him:—his moral susceptibilities are not adapted to them:—and therefore he cannot know them because they are spiritually discerned.—And it is a gross state of sensuality, and consequent intellectual and moral stupidity and darkness, which the Scriptures signify when they say, “The heart of this people is waxed fat or gross, and their ears are dull of hearing, and their eyes have they closed, lest they should see with their eyes and hear with their ears, and understand with their heart, and should be converted and I should heal them.”—Hence the New Testament is replete with passages affirming the intimate relation between the carnal influences and the moral character of man, and earnestly exhorting and entreating believing Christians to crucify the flesh with the lust thereof—to walk not after the flesh—to suffer not sin to reign in the mortal body by obeying the lusts thereof—

to keep under the body and bring it into subjection—to present it a living sacrifice, holy, acceptable to God—to render it a temple of the holy Spirit—even of the living God.—Because the flesh lusteth against the spirit and the spirit against the flesh;—and the minding of the flesh is death, because of sin—or the transgression of the constitutional laws of the animal, intellectual and moral nature of man: but the minding of the spirit of truth, is life and peace, because of righteousness, or the obedience of those constitutional laws:—and consequently, he that soweth to the flesh, shall of the flesh, reap corruption;—but he that soweth to the spirit, shall of the spirit reap life everlasting. And therefore godliness, or the strict obedience of the laws which God has constitutionally established in the animal, intellectual and moral nature of man, is profitable or serviceable to all,—having the promise of the life which now is and of that which is to come.

§ 634. The moral faculties being constitutionally inherent in human nature, man is therefore necessarily a religious animal:—but there is no constitutional necessity nor certainty that his religion will be the religion of truth.—We have seen (§ 613.) that, the corporeal nature of man holds, in common with all material forms and substances, a fixed constitutional relation to God as its intelligent and omnipotent first, and continually efficient Cause, and that the moral nature of man holds a fixed constitutional relation to the moral character of God, as a moral Governor, Judge and Father: and that the constitutional laws of man's moral nature perfectly harmonize with the constitutional laws of his animal nature, so that, the perfect fulfilment of the one requires the perfect fulfilment of the other; and the violation of the one is necessarily attended with an infraction of the other: and

furthermore that, the moral and religious instructions of the Gospel of Jesus Christ, perfectly harmonize with the constitutional laws of man's moral and animal nature. True religion consists then, in perfectly obeying all the constitutional laws of human nature:—for this would be fulfilling our twofold relation to God,—our duty to ourselves and our relations to our fellow creatures:—and thus we should love God with all the heart, soul, mind and strength, and our fellow creatures as ourselves.—But, human nature has always come short of this perfect fulfilment, and from the delinquency has sprung all the natural and moral evils that man experiences in this world. And the Gospel affirms that man has thus failed, through the weakness of the flesh, and therefore that God has established an economy of grace, in which he will accept the true and sincere *spirit to do*, though man, in the frailty of his nature, comes short of the perfect fulfilment of law. But this economy of grace does not save man in the present state of being, from the penalties which must necessarily result from the violations of the constitutional laws of his animal nature.

§ 635. If from inattention to true evidence (§ 629.) or want of information,—from sensuality (§ 630.) or any other cause, the understanding remains unenlightened and undecided under the promptings of the moral sense, (§ 622.) the mind is thrown into a state of painful perplexity, and not perceiving distinctly where the truth lies, and still fearing lest it should not embrace every point in which it may lie, it is led to give importance to things, in themselves wholly unimportant,—even to the extent, in some cases, of making an object of worship of a lifeless image or of a “four-footed beast or creeping thing.”—This is SUPERSTITION.—If through the power of the carnal influences or any other cause, (§ 630.) the

mind is led to lay hold of erroneous evidences, or inaccurately weigh the true evidence presented to it, and thus, the understanding is fully brought to erroneous conclusions, under the influence of the moral sense, (§ 632.) these conclusions will constitute a false conscience:—and on these conclusions man builds the superstructure of his future interests and hopes;—and with such associations, they become of the utmost importance to his feelings, and he consequently regards with extreme jealousy, every thing which seems to militate against them. This is **BIGOTRY**.—When the passions become excited in behalf of these conscientious errors, man often pursues them with the utmost exercise of all his energies; and perhaps accomplishes more evil in the pursuit,—and performs more deeds of horror, than under any other cause of action. This is **FANATICISM**.—Yet in all this error, the moral sense speaks but one thing—“be right!—be right!”—The evil therefore lies in the errors of the understanding, and the errors of the understanding arise mainly if not entirely, on moral and religious subjects, from the influences of the carnal nature.

§ 636. According, then, as man uses the powers and means which he possesses and which lie within the reach of his capabilities,—so will his religion be true, or false.—If true, it will lead to his highest and best condition.—If false, it leads to his greatest evil.—But whether his religion be that of truth, unto good—or of error unto evil,—man must be religious, or cease to be what he constitutionally is!—His religion may indeed, be nothing but the most savage and degrading superstition and idolatry:—or, if possible, it may be of a still lower and more brutal order than this:—or it may run into the most atheistically religious fanaticism against religion!—but still, ransack the earth and ocean, and wherever you

find a human being who is not an idiot—however savage his condition—however low his state,—if you are capable of studying man, you may find in him the constitutional rudiments of a moral and religious character.

§ 637. If man therefore, be not led to the religion of truth, and thus exalted to his highest and best condition—to a holy and happy alliance with his benevolent Creator, he will, with inevitable necessity, sink into the religion of error, and thus be degraded to wickedness and misery, in proportion as he departs from the truth constitutionally established in his nature.—And in proportion as the mind becomes darkened, and the conscience erroneous, and the moral sense blunted or feeble, man becomes less and less capable of ascertaining moral truth, and of perceiving and understanding spiritual things; and more and more inclined to carnal forms and ordinances, and the worship of sensible objects, and to the grossest and most degrading idolatry.

§ 638. Finally:—we see from the views which have now been presented, that man has an animal nature, endowed with intellectual and moral powers; (§ 612.)—that his intellectual powers naturally obey the propensities, appetites and desires of his animal nature, (§ 607.) whether originally instinctive, or acquired; (§ 608.)—that the grand law of action in the animal nature of man is—self-indulgence;—that all transgression of the constitutional laws of the animal nature of man, in supplying the natural wants or in gratifying the natural propensities, necessarily more or less, depraves the natural instincts and sensibilities of the body, and rapidly generates new wants, new appetites and propensities, which act on the intellectual and voluntary powers with a much more imperious and despotic energy than the natural ones, and always tend to excess, and lead to the destruction of the

individual and the extinction of the species;—that the moral powers are established to preside over the operations of the intellectual faculties, with a determinate reference to the constitutional laws and relations of human nature:—and therefore that, their office is to prompt the mind to find out, and the individual to obey the constitutional laws and relations of his nature. And in doing this, the moral sense cannot in itself, tell what is true or right:—nor has it any ability to tell whether the conclusions of the understanding are correct or erroneous. It can only say to the understanding with more or less energy and importunity—“be right!—be right!”—and whatever the understanding fully and confidently determines to be right, the moral sense necessarily receives and enforces as right;—and this is the CONSCIENCE. Therefore when the conclusions of the understanding are strictly true, the conscience is true:—but if by any means the understanding is fully brought to erroneous conclusions under the promptings of the moral sense, the conscience is false. And consequently, the fact that a man is conscientiously sincere in a thing, is no proof that the thing is right:—nor is the fact that, a man's conscience does not reprove him in what he does, any proof that he is not acting morally wrong.

§ 639. My analysis and philosophy of the moral powers thus far, are perfectly reconcilable to the views of Gall and Spurzheim, except that they make the brain of more exclusive importance than I do (§ 598.) and attribute much less to the physiological and pathological powers and conditions of the nerves of organic life, and the organs of relation.—They study man more exclusively within the brain, (§ 602.) while I insist much more on the physiological laws of his whole organization.—They may be correct in asserting that man has other innate moral

faculties, such as benevolence, veneration, &c. If there be such innate powers—and there is much and strong evidence of it—it is entirely certain that the philosophy of them in the moral constitution and character of man, is precisely the same as that which I have now explained of the moral sense. (§ 1244.) And with the application of this general physiological philosophy to all the cerebral organs described by Gall and Spurzheim, I should have much less objection to their theory, because I believe it would thereby be rendered much more consistent with truth, and stripped of its most objectionable features.

LECTURE XI.

How long can man live?—The testimony of Moses and other ancient writers concerning primitive longevity—Primitive computation of time—If man ever lived a thousand years, all the stages of life must have corresponded in relative length;—childhood and youth, much more protracted, &c.—Physiology cannot tell how long man can live, fact must determine it—The Mosaic record of primitive longevity from Adam to Jacob—Causes which have abbreviated the life of man—The great economy of Providence by which the physical constitution of man is renovated—The successive stages of society—The grand experiment of mankind in regard to the vital power of endurance—The history of this experiment from Adam to Noah and thence downward; and the grand result—The lowest point of constitutional power—The savage state not natural to man—Uncertainty of testimony concerning the experience of man—Anecdote of the two aged witnesses—Great misapprehension of facts—How far the facts of experience in individuals and nations may be useful to physiological science—Physiological science alone can determine how man should live—Experimental fact alone can determine how long man *can* live—The human constitution essentially one—If one man can live a hundred

years, others may be made to—Those of feeble constitutions often live to much greater age than those of powerful constitutions—The present capabilities of the human constitution—Scriptural objections answered—But old age is not desirable—Decrepitude and dotage not essential to old age—Youthfulness, vivacity, health, activity, cheerfulness, usefulness and enjoyment may be preserved, and in a good measure carried up to the last hours of extreme old age—To live long is not only desirable but a duty—The preservation of youthfulness, vivacity and cheerfulness, a duty—How this may be done.

§ 640. HAVING taken a general survey of the anatomy and physiology and pathology of man as an intellectual and moral animal; and contemplated the wonderful complexity and delicacy, and the fearful liabilities of his organic machinery, the question which next presents itself for our consideration, is—How long can the vital powers of the human constitution, through the operation of this assemblage of organs, resist the causes which induce disorder, and death, and maintain their control over the matter which composes their organic structure?

§ 641. According to the Mosaic history, the first generations of the human race, lived several hundred years, and some individuals attained to nearly a thousand: and Josephus, who lived in the commencement of the Christian era, and who was extensively acquainted with the writings and traditions then called ancient,—and “saw many works entire of which we have now, but a few scattered fragments, assures us that, the tradition of this longevity extended through all antiquity.”—He assigns as a reason for the great longevity of the primitive generations, that the human constitution was then vigorous and fresh from the hands of the Creator, and the food of man was then fitter for the prolongation of life:—and he affirms that all the writers of antiquities, both among the Greeks and Barbarians, admit the longevity of the first ages. “For even Manetho,” says he, “who wrote

the Egyptian history, and Berosus, who collected the Chaldean monuments; and Mochus and Hestæus, and Jerome the Egyptian, and those that composed the Phœnician history, all concur in testifying to this primitive longevity. Hesiod also, Hecataeus, and Hellanicus, and Acusilaus; and besides these, Ephorus and Nicolaus relate that the ancients lived a thousand years.”—Lucretius the Roman poet, among other Latin writers, also asserts the great longevity of the first generations of the human race, and says that they were hardy “because the hard earth produced them.” And that—

“ Their sinewy limbs were firmly knit and strong,
 Their life was healthy and their age was long,
 Returning years still saw them in their prime;
 They wearied even the wings of measuring time!”

§ 642. There has been much speculation in modern times, concerning the length of the years spoken of by Moses and other early historians, in reference to the period of human life, in the primitive ages of the world. Hufeland, a distinguished German physician, thinks “it has been made to appear in the highest degree probable, that, the year, till the time of Abraham, consisted only of three months;—that it was afterwards extended to eight;—and that it was not till the time of Joseph, that it was made to consist of twelve.” “These assertions,” he continues, “are, in a certain degree, confirmed by some of the eastern nations, who still reckon only three months to the year; and besides, it would appear altogether inexplicable, why the life of man should have been shortened, one half, immediately after the flood.—It would be equally inexplicable why the patriarchs did not marry till their sixtieth, seventieth, and even their hundredth year:—but this difficulty vanishes when we reckon these ages according to the before-mentioned standard, which

will give the twentieth or thirtieth year; and consequently, the same periods at which people marry at present.—The whole account, therefore, according to this explanation, assumes a different appearance. The sixteen hundred years before the flood, will become four hundred and fourteen, and the nine hundred years which Methuselah lived will be reduced to two hundred; an age which is not impossible; and to which some men, in modern times, have nearly approached.”

§ 643. The whole argument against the great longevity of the primitive inhabitants of the earth may be resolved to the following syllogism. Man rarely attains to more than a hundred years, in the present age of the world:—nor has he for many centuries past; and few, even reach seventy years. But man now lives nearly or quite as long as the human constitution can be made capable of resisting the natural causes of its destruction. Therefore, man never attained to a much greater age than he now does: and consequently, the accounts of the extraordinary longevity of the antediluvians, must either be wholly fabulous, or the years which they are said to have lived, must have consisted of a much shorter period of time than the present year.

§ 644. The whole then comes to this:—The constitutional capabilities of man, have from the beginning, to the present time, always remained very nearly the same. But this reasoning appears to me to be very inconclusive, and without any foundation in true physiological science. A thorough investigation of the conditions and laws of organic life, (§ 121. *et seq.*) clearly shows that, from the constitutional nature of things, there must necessarily be a termination to human existence sooner or later;—but there is nothing in physiology, nor in any other known science, which proves that man cannot as well live a

thousand years, as fifty. The bare facts then, that man does not live a thousand years, and has not, for many centuries past, constitute the only foundation for the assertion that he cannot live a thousand years, and therefore that, he never did live a thousand years. From all we know however, of the laws of life in connexion with the organized matter of the human body, we have not the least physiological reason for believing that those conditions and operations of the living organs, on which the continuance of life depends, (§ 133.) may not be sustained, in a possible state of the human constitution, for many hundred years.—But if there ever was such a state of the human constitution, that state necessarily involved a general keeping of parts, or harmony of proportions or relative conditions. The vital processes were much less rapid and intense and much more complete than at present,—the development of the body was much slower, and the organization much more perfect: childhood and adolescence were proportionately protracted: and the change from youth to manhood, took place at a much greater remove from birth: and boys were lads at thirty, and young men marriageable at seventy or a hundred years of age.—The descent from such an elevated state of the human constitution to the common level of the human race since the time of Moses, would necessarily be more or less rapid and precipitate, according as the habits of mankind were more or less conformable to, or in violation of the laws of life.

§ 645. But while, on the one hand, physiological science affords us no proof that man cannot live a thousand years, neither does it on the other hand, afford us any proof that he can live even ten years.—Facts and testimony therefore, constitute our only authority on this point:—and although, as I have shown, (§ 641.) the tra-

dition of the great longevity of the primitive inhabitants of the earth, ran through all antiquity, and is asserted by all the Greek and Barbarian historians, who, two thousand years ago, wrote what was then called the ancient history of the human race, yet the Sacred Books written by Moses, are unquestionably the most ancient and perhaps the only authentic testimony which has come down to us, on this interesting subject. And according to the Mosaic record Adam lived 930 years—Seth, 912—Enos, 905—Cainan, 910—Mahalaleel, 895—Jared, 962—Enoch, 365—Methuselah, 969—Lamech, 777—Noah, 950—Shem, 600—Arphaxpad, 438—Salah, 433—Eber, 464—Peleg, 239—Reu, 239—Serug, 230—Nahor, 148—Terah, 205—Abraham, 175—Isaac, 180—Jacob, 147.—The period signified by the word year, in this record, appears to mean precisely the same length of time when applied to Adam and Methuselah that it does when applied to Abraham, Isaac and Jacob:—or in other words, Moses appears to have used the Hebrew term which is rendered “year” in our English Bible, for precisely the same length of time, when speaking of the age of the antediluvians, and when speaking of that of the postdiluvians. And therefore, if we are to understand from the Mosaic record that Methuselah lived but 242 of our years, then the patriarch Jacob lived but 37 years.—It is highly probable, however, that the average period of life, of the individuals named by Moses, from the creation to the flood, is considerably greater than the average period of human life, in the whole species during the same time. Nor is the rapid abbreviation of the period of human existence after the flood, by any means inexplicable or marvellous, even if it be admitted that Noah actually lived 950 of our years.—It is indeed, no uncommon thing to meet with facts perfectly analogous in our own times.

§ 646. Whatever may be true, however, as to the precise length of the period of human existence before the flood, it cannot reasonably be doubted that the primitive generations of mankind very greatly exceeded in length of life, the present inhabitants of the earth. Nevertheless, it appears very evident that, for the last three thousand years, the general average of human life has remained pretty nearly the same.

§ 647. How far the changes which have taken place in the earth and its atmosphere, may have been concerned in the abbreviation of human life, cannot be known. It is probable that such changes have at times affected animal life very generally and with great power, as epidemic causes of disease and death: but there is no reason to believe that any permanent constitutional change has taken place in the atmosphere, nor any change in the condition of the earth, by which the human constitution has been permanently impaired, to any considerable extent. Nor is there reason to believe that any thing more than natural causes have operated to produce whatever changes have taken place in regard to the longevity and general condition of the human race:—and among these, the most powerful are unquestionably those which are connected with human agency and within the control of human ability.

§ 648. The whole history of the human race fully proves that man is so constituted as an intellectual and moral animal, that those excesses which deprave and deteriorate his nature as an individual, (§ 609.) and lead to his individual destruction, and to the degeneracy of the human constitution, and the extermination of the species, inevitably so affect him in his social and political capacities and relations, as that, while they impair all the energies of the human constitution, and fit man to be the

progenitor of a still more degenerate progeny, and thus gradually lead to the extermination of the race, at the same time so impair the energies of his intellectual and moral powers, so ingulf his social and civil virtues in selfishness and sensuality, as to render him incapable of sustaining those social and civil institutions and political conditions, by which he is protected in his degenerating luxuries and excesses, and fit him to become an easy prey to the hardier and more warlike portions of his race,—or to sink by a general decay of state and civil feuds, into an equally degraded condition of vassalage or slavery or barbarian rudeness,—in which, with the loss of science and literature, and all the elegant refinements of civic life, he is also stripped of those luxuries, and compelled to forego many if not all of those enervating and deteriorating habits and circumstances, by which his whole nature has been reduced to the very brink of utter destruction: and thus, like the king of Babylon, he is driven forth from the excesses of his voluptuousness and general sensuality, and forced to subsist in the simplest and rudest manner, in a state of little more than animal existence.—From this state, he slowly rises by the gradual cultivation of his intellectual and moral powers, and of the social and civil virtues, till, with renovated physical energies and constitutional powers, he attains to what is universally called the golden age, in which all the circumstances of his existence, seem to be best adapted to human health and longevity and virtue and happiness. To this, generally succeeds the age of heroism and conquest, and then follows the age of stern and noble patriotism, and legislative wisdom, and political energy and power. The age of wealth comes next, and with it, brings the age of luxury and refined sensuality and excess. Multiplying Disease raises its admonishing voice, in vain. Pestilence

peals a louder and more terrific note of rebuke, and man in the moment of dismay, at first refrains from his excesses, and affords his constitution an opportunity to gather up some of its prostrated energies. But his partial reformation too often proves to be only a preparation for greater excesses than before, and he rushes onward in the current of indulgence, till even the terrible rebukes and chastisements of pestilence, seem only to harden him and increase his temerity until he revels in maniac sensuality even in the lazaretto, and yields to the fierceness of his beastly lust upon the very threshold of the charnel house. In this fearful manner, the nations of the earth have been scourged till it seemed as if the human race would be wholly exterminated:—and only by such severe and awful retributions from the violated laws of nature, have mankind been induced to pause from their sensual excesses, and investigate even the most obvious relations between their habits and their sufferings. Nor has all this been sufficient, so to restrain them in their downward course, as to prevent the necessity for those mighty revolutions, which, from the beginning, have continued to roll up barbarian hordes to the zenith of civilization and luxury, and to roll down civilized and refined nations to the nadir of barbarian darkness. And thus, the human constitution has, from time to time, been partially renovated, and the human race perpetuated, by the very means which have often almost blotted the intellectual and moral man from the face of the earth!

§ 649. Indeed, it seems as if the grand experiment of mankind had ever been to ascertain how far they can transgress the laws of life—how near they can approach to the very point of death, and yet not die,—at least, so suddenly and violently, as to be compelled to know that, they have destroyed themselves.

§ 650. The primitive inhabitants of the earth, having once broken away from the simplicity and truth of nature, and begun to acquire artificial appetites, of far more despotic power (§ 608.) than nature's holy instincts, rushed forward to new indulgences, with increasing eagerness and celerity, and plunged downward to deeper and yet deeper sensuality,—impelled by a continually accumulating moral force arising from their more and more depraved and more vehement and tyrannous propensities, till the horrible enormities of human wickedness rose up to heaven, and God, in very mercy, quenched the bursting volcano of human passions by the flood; and almost entirely exterminated the family of man, to save the earth from a bloodier deluge and a darker desolation, and man from a more violent and cruel end. And when the earth rose from her deep baptism, sanctified from the pollutions of a drowned race, the remnant of that race, which God had saved for the perpetuation of the human kind, came forth with appetites unsanctified by the terrible ablution of the world, to commence anew the downward and ruinous career of sensual excess.—And surely, if the patriarchal father, who, of all the earth's inhabitants, was most virtuous and most acceptable to God, brought with him from beyond the flood, an appetite, which, in spite of the awful judgment he had seen inflicted on a sinful world, led him to the excess of most disgraceful drunkenness, as soon as he could procure the means, it cannot be supposed that, with such an example and such opportunities before them, the sons of that patriarch—born and reared as they had been, amidst the fiercest excesses of the old world's sensuality and violence—were more abstemiously and virtuously inclined than was their aged sire.

§ 651. It is not strange therefore, that their lives were

much abbreviated by their excesses; (§ 645.)—nor that the succeeding generations of mankind, pursuing the same downward career of sensuality, should suffer a continual abbreviation of the period of their existence, till repeated calamities had forced them to ascertain the lowest point to which they could descend without exterminating the human species.

§ 652. From that time to the present, mankind have revolved around the minimum point of constitutional power, in the circle which I have described, (§ 648.) from savage to civilized life and luxury and every deteriorating excess; and from this, to savage life again, and thence slowly rising to the golden age, and then again declining. And consequently, though, in these succeeding revolutions, the succeeding nations of the earth have had their elevation and declension, yet the average level of human life has been nearly the same for the last three or four thousand years.—Each nation has had its period of longevity, its age of heroism, conquest, patriotism, legislative wisdom, political energy, wealth, luxury, &c. It is also true that, the general average of life often runs low in a nation which at the same time has many instances of individual longevity: and on the other hand, the average period may be considerably elevated when there are few remarkable cases of individuals who attain to very old age. Both of these facts may easily be explained, on the plainest principles of physiological philosophy. But were I to follow out all the leadings of this interesting subject, the extent of my investigations would necessarily far exceed the bounds which I have set for myself on this topic of inquiry.

§ 653. The lowest point of constitutional power by which the human species can be preserved, is that which will sustain a sufficient number of each generation long

enough in life to become the progenitors, and nurturing protectors of another generation. When it falls short of this, the human race tends rapidly to extinction;—and in this manner, particular families are very frequently exterminated, and even whole tribes are sometimes cut off. But as we have seen, (§ 648.) a wise and benevolent Creator has so constituted things, that the human species as a whole are not permitted to go beyond certain limits, without falling into that condition, in which intellectual elevation, science, literature, and all the elegant refinements and deteriorating luxuries of civic life are sacrificed for the physical renovation of human nature. Yet if by any means the human race can be kept sufficiently above the minimum point of constitutional power, the species can be preserved without the renovating process of which I have spoken,—or without a recurrence to the severe simplicity and privations of the savage state. Be it remembered however, (§ 25. Note) I do not affirm that the savage state is best adapted to human health and longevity:—but that this state of severe privation and rudeness, has hitherto been necessary to strip man of the means of luxury and excess, and thus afford his constitutional powers an opportunity to recover in some degree their impaired energies. Yet the savage state is generally attended with many circumstances which are decidedly unfavorable to health and longevity; and often with extreme violations of the laws of life.

§ 654. Well regulated civilized life is therefore, unquestionably best adapted to the full development of the physical and intellectual and moral capabilities of man: and it is a necessary truth established in the constitutional nature of things, that not only individual health and happiness and prosperity, but also the political prosperity and durability of nations, are, as a general statement, always

proportionate to the degree of conformity of the people to the laws of life.

§ 655. To ascertain what those causes are, by which the period of human existence is abbreviated, and by what means we may with greatest certainty, not only secure the longest life, but also the highest degree of health, and the greatest amount of happiness, consistently with those principles on which our highest intellectual and moral good depends, must necessarily be regarded by all truly rational creatures as of the utmost importance.

§ 656. In pursuing this investigation however, we meet with many and great difficulties:—not from any uncertainty of physiological principles; but from the almost impossibility of ascertaining real facts; because we are obliged, to a very considerable extent, to take the testimony of others, in regard to things which we have not the opportunity to examine for ourselves. And unfortunately for the human race, too many that have been considered valid sources of information, have only served to mislead mankind and to establish those erroneous opinions, from which have sprung some of the most pernicious practices which have afflicted our species.

§ 657. We have been told that, some men enjoy health and live to great age in warm and in hot climates; and that others enjoy health and live to great age in cold climates: (§ 15.)—some on one kind of diet and some on another:—some under one set of circumstances, and some under another:—therefore, what is best for one man is not for another:—what agrees *well* with one, disagrees with another:—what is one man's meat, is another man's poison:—different constitutions require different treatment:—and consequently, no general rules can be laid down, which are adapted to every man, in all circumstances, and which can, with propriety, be made the laws of regimen to all.

§ 658. These erroneous dogmas, so far as the world is now informed, were first advanced by Hippocrates, and with all servility, have been handed down from generation to generation, till they have become the common sentiments of mankind; which he who questions, will incur the charge of rashly contradicting the common sense and universal experience of the human family. And hence, the common mode of reasoning on this important subject, is necessarily and exceedingly erroneous:—and never more so than when it is supposed to be truly and rigidly inductive.

§ 659. Among the numerous illustrations of the truth of the common notions, which I have just stated, the anecdote of the two aged witnesses who appeared before the civil magistrate, is often repeated by those who are willing to observe no other rules of life than the leadings of their appetites.—It is said that on a certain occasion, there appeared before a civil magistrate, a very aged witness, who possessed so much bodily vigor and elasticity, and retained his mental and moral faculties so remarkably, as to attract the particular attention of the court;—and when the trial was closed, the magistrate asked him how old he was.—“The days of my pilgrimage are a hundred years; may it please your honor!” was the old man’s reply.—“And by what means,” inquired the magistrate, “have you reached such an advanced period of life and retained all your faculties and powers so well?”—“May it please your honor,” the old man replied, “I was born of healthy parents, and from my youth up, have led a regular and temperate life.—My food has been simple and plain, my drink has been water, I have retired to rest in good season and risen early; I have been careful to govern my passions, and to preserve a great serenity and uniformity of mind and habit. In short, I have been

always systematically regular and temperate in all things.” —Pleased with the old man’s appearance and his history, the magistrate embraced the occasion to expatiate on the virtues of temperance and good habits, and to exhort the numerous audience to follow the example of this “green old man.”—Soon after this, another aged witness appeared before the same magistrate, who was equally remarkable for his bodily health and vigor, and for the soundness and energy of his mental and moral powers.—He also was asked by the magistrate how old he was, and by what means he had preserved his life and health and all his faculties in so vigorous a state.—“May it please your honor,” said the aged witness, “I am a hundred years old.—I have taken no pains to preserve my life or health. I have followed no rules, but have led an irregular life. I have always indulged my appetite in just what it craved; I have eaten what I wanted, when I chose, and as much as I desired; and my food has generally been rich and savory.—I have always drunk wine, beer and ardent spirit freely and often to great excess. In short, I have lived just as it happened, and am now living and well as your honor sees me, because my life and health have been continued to me, and not because I have taken any pains to preserve them.”—The magistrate was exceedingly confounded by this man’s statement, and only remarked that he perceived that some men would attain to old age in one way, and some in another.

§ 660. Those who repeat this fabulous anecdote, seem to think that it is a true narration of facts, and that it fully proves the entire futility of all rules for the preservation of life and health; and completely demonstrates that a vigorous old age is attained to, with as much certainty in one way as in another.—But in the first place, this story bears the evidence of fiction and of falsehood on its

very face: for although it is possible that, a man of remarkably powerful constitution, may live till he is a hundred years old, and retain his faculties and powers in considerable vigor, whose habits have been such as the second witness in this story is made to declare his own to have been, yet it is not possible for two persons, with an equally excellent original constitution, to reach a hundred years, with habits of life so different as those stated of the two witnesses in this story, without the most marked and manifest difference of appearance and condition of body and mind:—and a difference too, which would afford the strongest evidence in favor of a temperate and regular life. Therefore, in the second place, if this story were true, it would afford no evidence in favor of the position which it is intended to establish:—but would simply go to show that, the first witness, with an ordinary or perhaps feeble constitution, had by virtue of correct habits, attained to a remarkably healthy and sound old age; while the second witness had reached the same age with equal health and vigor, in spite of exceedingly bad habits, by virtue of a most extraordinarily powerful constitution.

§ 661. Yet, without taking the pains to examine all the circumstances of the case, most people consider the bare fact that some intemperate and irregular individuals reach a vigorous old age, a conclusive evidence that such habits are not unfavorable to long life;—or that a man of intemperate and irregular habits is just as certain of reaching a hundred years, as one of the most temperate and regular habits is;—and therefore almost every body has a demonstration of this kind in the history of some kinsman or neighbor or acquaintance, or somebody else. And with the same loose kind of inductive reasoning people arrive at conclusions equally erroneous, in regard

to tribes and nations. If a tribe or nation which subsists on vegetable food is weak, sluggish and destitute of courage and manly enterprise, it is at once concluded that vegetable food is the cause; and the general proposition is laid down that an exclusively vegetable diet is not favorable to bodily strength and activity and mental vigor and sprightliness. Yet a proper examination of the subject might have shown that other causes fully adequate to these effects, existed in the condition and habits of that tribe or nation, which not only exonerated the vegetable diet from this charge, but even made it appear, that the vegetable diet had a powerfully conservative and redeeming effect, and was the principal means by which the tribe or nation was saved from a much worse physical, mental and moral condition.

§ 662. Again, if savage tribes or nations are unprolific, feeble, sickly and short-lived, it is at once concluded that the naturalness and simplicity of savage life, are unfavorable to bodily development and vigor and health and longevity. Yet a proper examination of the subject might have shown that causes existed in the habits of such tribes or nations, not at all essential to savage life, and directly opposed to true naturalness and simplicity, which were abundantly sufficient to account for all the objectionable effects attributed to savage life. (§ 25. Note,)

§ 663. The conclusions therefore, which are drawn from the habits of individuals and of nations, can be depended on no farther than they agree with the laws of life, ascertained by an accurate and thorough investigation of the vital properties of the tissues and functional powers of the organs, and the general operations and results of the vital economy of the human system.

§ 664. So far as a general agreement exists between

all cases of remarkable longevity, some respect is to be paid to facts:—and these may be adduced as illustrations of principles otherwise established.—But the fact that an individual, or a number of individuals have attained to a great age, in certain habits of living, is no conclusive evidence that those habits are most conducive to long life, nor even that they are all favorable to longevity. The only use therefore, which we can safely make of a case of extraordinary old age, is to show how long the human constitution is capable of sustaining the vital economy and of resisting the causes which induce death.

§ 665. If we would correctly ascertain how man must live in order to secure the most perfect health and attain to the greatest age of which the human constitution is capable, we must not ransack society to find all the remarkable instances of longevity, and learn the particular habits of those who have attained to old age:—for such a course would only serve to bewilder and perplex us, and lead us to conclude that the whole question is involved in the most entire uncertainty: because we should find health and old age in almost every variety of circumstances in which mankind are placed; and if we were not fully qualified for the severest and most critical investigation of such an intricate subject, we should inevitably misapprehend facts, and thus be led to erroneous conclusions:—but we must study the human constitution with the most rigorous scrutiny of science.—We must analyze the human body to its organic elements, (§ 122. 123.) and become thoroughly acquainted with all the elementary tissues (§ 156.) which enter into the formation of all its organs, and fully understand the peculiar vital properties of all those tissues (§ 312.) and the functional powers of all the organs. We must intimately and accurately know all the conditions on which the peculiar

properties of the tissues and powers of the organs depend, and the various causes and circumstances by which those properties and powers are favorably or unfavorably affected.—In short, we must ascertain all the properties and powers which belong to the living animal body, and all the laws of constitution and relation appertaining to the vital economy of the human system.—Here, and only here, can the enlightened and truly scientific physiologist take his stand, and teach those rules of life, by which man may with greatest certainty secure the best health and attain to the greatest longevity of which the human constitution is capable.

§ 666. But while the truly scientific physiologist, from his intimate and thorough knowledge of all the properties and powers, and laws of constitution and relation, belonging to the human body, instructs us how to live in order to secure the highest degree of health, and attain to the longest life of which the human constitution is capable, he cannot from this knowledge, tell us what the capabilities of the human constitution are in regard to health and longevity. He can tell us with accuracy and confidence that, such and such are the laws of life—and such and such are the best means by which health may be secured and life prolonged:—but he cannot, from his physiological knowledge, tell us whether a strict obedience to the laws of life, and a correct use of the best means, will prolong our life ten, or a thousand years.

§ 667. If therefore, we ask the truly enlightened physiologist, *how* we must live to secure the best health and longest life of which our constitution is capable,—his answer must be drawn purely from his physiological knowledge:—but if we ask him how long the best mode of living will preserve our life?—his reply is, “Physiology cannot teach you that. Therefore, now go you out into

the world and find the oldest man living and enjoying health.—If after having obeyed his command, we return and say to him, we have found several individuals a hundred years old and all enjoying pretty nearly the same degree of health; yet they are of very different and even of opposite habits; his answer will be that, probably each of the individuals whom you have found has a mixture of good and bad habits, and has lived in a mixture of favorable and unfavorable circumstances, and that, notwithstanding the apparent diversity of habits and circumstances among them, there is probably a pretty nearly equal amount of what is salutary and conservative in the habits and circumstances of each and all. Some of them have erred in one thing and some in another, and some have been correct in one thing and some in another; and therefore the diversity of which you speak is probably more apparent than real, in relation to the true laws of life. Besides, some, with an extraordinarily powerful constitution, may, in the constant violation of the laws of life, reach a hundred years with as much health and vigor, as others who attain to the same period in much better habits and circumstances, but with far less powerful constitutions. All that is proved therefore, by instances of great longevity in connexion with bad habits and circumstances, is that, such individuals possess remarkably powerful constitutions, which are able to resist for ninety or a hundred years, causes that have in the same time sent hundreds of thousands of their fellow creatures, of feeble constitutions, to an untimely grave; and which, under a correct regimen, would in all probability have sustained life and health a hundred and twenty, and perhaps a hundred and fifty years.—The only use which you can safely make therefore, of the instances of great longevity which you have found," he would say, "is

to show how long the human constitution, in the present age of the world and condition of the race, is capable of resisting the causes which induce death:—and if you have found an individual or a number of individuals a hundred years old, it is of little importance to you how they have lived,—the simple fact that they are a hundred years old is all we wish, to prove that the human constitution is now capable of reaching a hundred years.”

§ 668. Physiology then, alone, can teach us how man must live in order to secure the best health and attain to the greatest age of which the human constitution is capable; and the fact that there are individuals now living a hundred years old, proves that the human constitution is capable of sustaining life a hundred years, at least, and perhaps much longer, if the regimen and circumstances are in all respects correct.—But here I shall probably be met with the very ancient and utterly absurd doctrine that, there are different constitutions, and therefore, that what may be true of one, cannot truly be affirmed of all.—It is freely admitted that, in the present state of the human race, some individuals have more vital energy and constitutional power to resist the causes of disease and death than others have, and therefore, what will break down the constitution and destroy the life of some individuals, may be borne by others a much longer time, without any striking manifestations of immediate injury.—It is also true that, in the present state of the human race, some individuals have strongly marked constitutional idiosyncrasies or peculiarities:—but these are far more rare and of a much less important character than is generally supposed; and in no instance constitute the slightest exception to the general laws of life; nor in any degree interfere with, or militate against the correct principles of a general regimen. Indeed such peculiarities, though really

constitutional, may in almost every case be overcome entirely, by a correct regimen. I have frequently seen the most strongly marked cases completely subdued by such means. It is an incontrovertible truth therefore, that so far as the general laws of life, and the application of general principles of regimen are considered, the human constitution is ONE; and there are no constitutional differences in the human race which will not readily yield to a correct regimen, and by thus yielding improve the condition of the individual affected: and consequently, there are no constitutional differences in the human race, which stand in the way of adapting one general regimen to the whole family of man:—but, on the contrary, it is most strictly true, that, so far as the general laws of life, and the application of general principles of regimen are considered, what may be truly affirmed of one man may be truly affirmed of all, and what is best for one is best for all; and therefore, all general reasonings, concerning the human constitution, are equally applicable to each and every member of the human family, in all ages of the world, and in all conditions of the race, and in all the various circumstances of individuals.

§ 669. Now therefore, if individuals can be found at the present time, who are a hundred years old, the fact may be adduced as a demonstration that the human constitution has vital power enough to resist the causes which induce death, and to sustain health for a hundred years, under whatever disadvantages may exist at the present period of the world, distinctly from the agency of man. But we know that there are many individuals now living and enjoying good health in different sections of our country, who are a hundred years old; and therefore, it may with perfect accuracy be affirmed that the human species in the United States of America, may average a hundred years of life.

§ 670. Is it objected, that, this is not a legitimate conclusion?—that, because one man reaches a hundred years, it is no proof that the human species may average that length of life?—I ask, by what means has one man lived a hundred years?—Will it be affirmed that he has been miraculously endowed with vital powers:—or that, his vital energies have from time to time been miraculously renovated?—Certainly not!—But, it may be asserted, that he had a remarkably strong constitution! This is not always the case. Plato in his Republic, strongly censures Herodicus, one of the preceptors of Hippocrates, for teaching the delicate and infirm to regulate their exercise and diet in such a manner, as to prolong their lives for many years; and thus attain to old age with a very feeble constitution. “He was master of an academy,” says Plato, “where youth were taught their exercise, and being himself delicate and infirm, he contrived to blend exercise with such dietetic rules as preserved his own feeble constitution from sinking under his complaints, and enabled him to protract his valetudinary existence to old age; and he did the same injury to many others of feeble and infirm constitutions.” This Plato calls an injury, because he considered an infirm constitution an obstacle to the practice of virtue; inasmuch as it makes people always imagine themselves ill and causes them to think of nothing but their own infirmities: and therefore he thought that, if a delicate person did not soon recover health, he had better die out of the way; and not live to be miserable himself, and to become the father of feeble children, and thus injure society and the race. Louis Cornaro, a noble Venetian, had completely broken down his constitution at the age of thirty-five, and had become so infirm that he despaired of ever recovering health, or of reaching the meridian of life: yet by greatly reforming

and simplifying his habits of living, he recovered health and lived to be over a hundred years old. The venerable Moses Brown, of Providence, R. I., now nearly a hundred years old* and enjoying uncommon health and activity for his age, informs me that, from his birth through the whole of the early part of his life, he was exceedingly delicate and feeble, and that his constitution has always been very delicate. He had three brothers who were all remarkable for their stout, robust and vigorous bodies, and powerful constitutions, yet neither of these brothers reached seventy years.—At the age of eighty-three, Moses Brown observed to a friend, “I was always a feeble, frail thing among my brothers, and had no expectation of out-living them:—I am persuaded that if I had had the constitution of either of them, and lived as I have lived, I should be an active, hale man at a hundred years old, and should probably live to the age of a hundred and ten or a hundred and twenty years in good health; but with my feeble constitution, I do not expect to exceed ninety years.”—The interesting case of this family is by no means an extraordinary one. It is no uncommon thing for the most delicate member of a family, by a careful regimen and generally correct habits, to attain to a very advanced period of life, while the more vigorous and hale members, by living too fast, are cut off in the middle of life, or perhaps in early manhood.—I could name a number of such instances.

§ 671. But granting the position, that, he who attains to a hundred years has a remarkably strong constitution: I ask, how the individual came to the possession of such a constitution?—Was it the special, direct, and extraordinary gift of the Creator?—or was it the natural result of a succession and concurrence of causes and effects

* Mr. Brown has since died of sickness from exposure, in his ninety-eighth year.

operating in the constitutional nature of things?—Most unquestionably the latter!—and these causes and effects, as a general law, are perfectly within the sphere of human agency, and under the control of human ability.

§ 672. If by any means, therefore, the human constitution can be made to resist the causes of death, and sustain health a hundred years, in one individual, by the same means, the same results can be produced in all: because he who attains to a hundred years, depends wholly on the intrinsic energies of the human constitution and on those circumstances and habits of life, which, as a general statement, are under the control of human ability.

§ 673. I do not however affirm, nor intend to imply that the present generation of the human species, can by any means, all attain to a hundred years of life. I know that in the present condition of the race, there is a very great inequality of constitutional power. Some individuals are born with constitutions too feeble to sustain the functions of life a single year:—others have power enough to maintain the victory over the causes which induce death for three, five, ten, twenty, forty, eighty, a hundred, or a hundred and fifty years.—Some are born without any strong tendency to a particular disease, while others are born with the most powerful predisposition to particular disease of some kind or other. But it is entirely certain, that all these constitutional differences result from the action of causes which man has the power to control: and therefore it is entirely certain, that all these constitutional differences can be removed in the course of three or four generations of the race, by a strict conformity to the laws of life, in all the members of each generation:—and the human species can be brought to, at least, as great uniformity as to their health

and length of life, as is found amongst all the lower animals in a pure state of nature.

§ 674. When I affirm that, the human species may average a hundred years, I do not mean to imply that the human constitution is not capable of exceeding that period.—As a physiologist, I cannot perceive any reason why the human race cannot return to the original longevity of the species: neither can I affirm, from any physiological knowledge, that man can live a hundred years. The bare fact that the human constitution does carry some individuals up to this period, is all the authority I have for affirming this capability of the human constitution:—but this fact by no means proves that the capability of the human constitution is only equal to a hundred years of life; because it is by no means certain that those who attain to the greatest age, always strictly conform to the laws of life; and therefore, we do not know but that many who die at a hundred years, might have reached a hundred and fifty years, if in all things they had obeyed the laws of life. Besides, were it a known truth, that in the present state of the human constitution, no individual possesses the power to live more than a hundred years, this would not prove that individuals cannot be produced in the fourth generation from the present, with constitutional power to live a hundred and fifty or two hundred years:—and I repeat that, correct physiological science affords no evidence that the human constitution is not capable of gradually returning to the primitive longevity of the species.

§ 675. On the whole then, true physiological science alone, can teach us how to live, in order to secure the best health and attain to the greatest longevity of which the human constitution is capable; and correct and continued experiment alone, can prove to us how long the

human constitution can be made to resist the causes which induce death, (§ 126.) and sustain the healthful operations of the vital economy.

§ 676. But I am told that, all this reasoning leaves God out of sight; and contradicts the sacred scripture which affirms that “the days of our years are threescore years and ten, and if by reason of strength they be fourscore years, yet is their strength labor and sorrow, for it is soon cut off and we fly away.”—I reply that, if God had actually and absolutely limited human life to seventy or eighty years, then no man could possibly exceed eighty years:—but we know that, many individuals do exceed eighty years of life, and that some exceed a hundred; and therefore, we have a perfect demonstration that God has not absolutely limited the length of human life to eighty or a hundred years; and consequently, we know that the scripture cited, is not the annunciation of a decree of God nor a prophecy; but simply a historical record of the fact that, at the time when it was written, human life rarely exceeded seventy or eighty years; and that those who attained to eighty years were extremely infirm, and helpless, and had little enjoyment of their existence. But Isaiah, when speaking prophetically of that period in the Gospel dispensation, when the laws of God shall reign in the hearts and govern the actions of mankind, explicitly affirms that, the period of human life shall be greatly prolonged; and that, there shall be no more thence an infant of days, nor an old man that hath not filled his days; but their days shall be as the days of a tree.

§ 677. As to my leaving God out of sight, I contend that all my reasoning is founded on the fixed laws which God has ordained and established in the nature of things. (§ 110.) I acknowledge that, God has the power

counteract or suspend the laws which he has established in the constitutional nature of man, as well as those which he has established in the constitution of the solar system; and I contend therefore, that it would be just as reasonable to assert that, the astronomer leaves God out of sight, in all his reasonings, because he calculates the movements of the heavenly bodies according to the fixed laws which God has established in nature, to govern their movements, as it is to raise that objection against the physiologist, because he reasons according to those fixed principles which God has established in the constitutional nature of man. If God has constructed man of such materials and upon such principles as render him capable of living just one thousand years and no more, by a perfect obedience of the laws of life; then God has actually set the utmost limits of human life at a thousand years, and beyond this point no means and no conditions can carry us. But if at the same time, God has established in our nature such laws of constitution and relation, as that, if man lives in a certain manner he can only reach seventy or eighty years, then it may be said that God has conditionally limited the period of human life to seventy or eighty years:—but this conditional limitation does not stand in the way of man's prolonging life to the full extent of the original capabilities of the human constitution.—If it is objected that, God foreknows, or has decreed the precise length of every man's life, and no human means nor conditions can add to, nor take from that fixed period a single hour or second of time; then I reply that God has also decreed the precise means and conditions by which the life of each individual shall be carried to its fixed termination: and God has just as certainly decreed the efforts which I make to secure human health and to prolong human life, as he has decreed the

length of any man's life:—and if he has decreed that the length of human life shall not be affected by my efforts, then he has also decreed that mankind shall give no heed to my instructions, but go on in their own ways, and fulfil their appointed time.

§ 678. Again, I am told that this is making a *long* life of more importance, than a *good* life, and leads people to think more of the welfare of the body than of the soul;—that it causes them to feel a security in life and consequently to neglect their religious interests.—But these objections are wholly founded in error. We have seen, (§ 613.) that such are the fixed constitutional relations between the animal and moral nature of man, and such are the fixed constitutional relations between man and his Creator and his fellow creatures, that the true principles of health and longevity, and the true principles of virtue and religion are inseparable. An individual, by a correct physical regimen, may maintain very good bodily health and reach an advanced period of life without any true piety and with very little moral virtue;—so also an individual, by embracing correct moral and religious principles, and cultivating correct moral and religious sentiments, may attain to much virtue and piety, without a proper regard to physical regimen: but in the former case the individual will come short of that perfect bodily health and enjoyment, and of that full duration of life—and in the latter case the individual will come short of that elevated degree of virtue and piety and happiness, which a full conformity to the laws of his whole nature would certainly secure to him. Therefore, if without any special regard to health and longevity, my only desire were to promote the highest and most perfect degree of virtue and piety in mankind, I would teach precisely the same principles that I now do. The consideration of the uncertainty of life,

may at first, serve to awaken our inquiries concerning our nature, our condition, our destiny and our responsibilities, and thus, to some extent, be the means of our becoming virtuous and pious. But the fear of death is not in itself, favorable to health nor long life;—neither is the dread of death nor the fear of punishment in itself virtue nor piety. The fear of hell is not the love of heaven;—nor is the fear of Satan, the love of God. It is only when we cherish and practise virtue because we love virtue, and love God because he is intrinsically lovely, that our virtue and piety are acceptable to God, felicitous to ourselves, and most beneficial to our fellow creatures:—and all the doctrines which I teach are adapted to lead men to receive and obey the truth in the love of it,—to be virtuous for virtue's sake, to dwell in God because he is Love; and thus at the same time and by the same principles secure bodily health, long life, elevated virtue and true and exalted godliness. “If ye know these things, happy are ye if ye do them.”

§ 679. But many say,—it is not desirable to live to be so old and decrepit and full of infirmities and ailments. Who, they demand, would wish to outlive their usefulness and enjoyment,—to lean in trembling feebleness upon the staff,—to sink into the helplessness of second childhood,—to have the senses one after another blotted out, and all the faculties of soul and body gradually decay, till we become a melancholy spectacle of human frailness and imbecility,—a burden to ourselves and all around us,—our dearest children wishing us in heaven?—This is indeed, a condition not to be desired!—nor is it the necessary condition of old age. They who make sensual enjoyment the chief end of their existence, and live in the continual violation of the laws of their nature, must of necessity, either perish untimely by violent disease, or

sink into that melancholy and shocking decay which is so common to old age. But that old age to which I would lead mankind is the rich and mellow autumn of our earthly existence,—that period of our lives in which the cares and conflicts of the world are left behind,—when all the passions are brought into subjection to a holy spirit,—when the mind is ripe in wisdom, and the moral character has reached its full, terrestrial maturity of virtue.

§ 680. We have become so accustomed to see the sprightliness and vivacity of childhood subside into the grave sobriety of mature age even before the period of youth has passed by, and the vigor and activity of meridian life wither into decrepitude and dotage long before a hundred years are numbered, that we have learned to think such things *must* be, and to contemplate old age only as the joyless period of feebleness, infirmity and exhausted powers and resources.—But though such things are the necessary consequences of certain habits and circumstances of life, in the present state of the human constitution, they are neither necessary nor natural to the constitution in its highest and healthiest state.

§ 681. In healthy childhood we see almost an exuberance of action, cheerfulness and enjoyment; and we love to behold the sprightliness and buoyancy of that period.—With a heart full of sympathy and delight the fond parent sees his child running and leaping like the playful lamb and colt, and rejoices in the happiness of his offspring; yet before that child has reached the age of manhood, if the baleful habits and circumstances of civic life have not completely blighted all his youthful sprightliness and vivacity, he is austere rebuked for every manifestation of them and sedulously taught to smother and disguise them with outward sedateness and gravity,

as if youthfulness of feeling and of action were not only improper but immoral: and if in later periods of life, something of the buoyancy of childhood should occasionally disclose itself, it is regarded as the effect either of mental delirium or of some intoxicating substance. For such is the general stupidity of the race, that the idea of natural youthfulness of feeling after man has reached the age of maturity, cannot be understood.

§ 632. But this is all wrong and unnatural, in notion and in fact. If sprightliness and vivacity and cheerfulness be innocent and pleasing in early childhood, why should they not continue to be so in youth and manhood, and all along through life, even to the latest period of our earthly existence?—There is no reason in nature why they should not; but every valid reason why they should!—and the opinion which is commonly entertained on this subject has sprung from sheer superstition growing out of the unhealthy state of things; and not from a sound and rational morality and religion. For, as we have seen, (§ 613.) no moral or civil law or religious doctrine can be adapted to the highest and best condition of man's moral nature, which is not strictly consistent with the physiological laws of his body, and it is entirely certain that the highest physiological interests of our nature require that *youthfulness* should be preserved and prolonged to the greatest extent. And youthfulness is as truly capable of being preserved and prolonged, as life itself is, and both depend on the same means and conditions.

§ 633. I have said (§ 644.) that, if there ever was a state of the human constitution which enabled it to sustain the functions of life for several hundred years, that state necessarily involved a general keeping or harmony of relative conditions. The vital processes were much less rapid and intense and much more complete than at

present;—the development of the body was much slower, and the organization much more perfect;—childhood and adolescence were proportionately protracted, and the change from youth to manhood took place at a much greater remove from birth. And whether the constitution be capable of a thousand or a hundred years of life, this keeping or harmony of relative conditions must always necessarily correspond with its capability of duration. Hence therefore, if in the present state of the human constitution, we would aim at the longest and healthiest and happiest life, we can secure our object in the highest degree possible, only by a strict conformity to those physiological laws by which youthfulness is also preserved and prolonged in corresponding proportion. And if by such means the duration of human life should, in the course of several generations, be prolonged to several hundred years, the period of childhood and youth would be proportionately protracted, and a much greater degree of youthfulness would extend through the whole duration of our earthly pilgrimage.

§ 684. We have seen (§ 124.) that all organic bodies are composed of solids and fluids. In the earliest state of our existence, the human body consists mainly of fluids.* All the solids are exceedingly soft and pulpy and moist or juicy.—As life advances, the solids gradually become more and more consistent and compact and firm, and their relative proportion increases upon that of the fluids, until, in old age as we now see it, they become comparatively dry and rigid; and sometimes extremely so. (§ 185. 188. 195. 200. 307.)

§ 685. All the solids of the body, we have seen, (§ 146.)

* The proportion of the fluids to the solids in the adult body, has been estimated as ten to one. In early childhood the difference is much greater.

are formed from fluids upon the most precise and determinate constitutional principles, and there are between the solids and fluids the most precise and fixed constitutional relations, (§ 142.) so that, in their perfectly normal and healthy state, they are, in their qualities and susceptibilities, perfectly adapted to act on, and to be acted on by each other, with the most healthful and happy effect; and the highest physiological and psychological interests of our nature can be secured only by the preservation of this state of things. (§ 301.) In this physiological condition of the system all the functions of life are healthfully and vigorously performed,—the organic and animal sensibilities are agreeably excited by their appropriate stimuli,— (§ 305.) the animal consciousness is grateful and joyous, and the spirits are buoyant and cheerful, filling the whole body and soul with sprightliness and vivacity.

§ 686. In early life, when the relative proportion of the fluids is greatest, when the susceptibilities and sensibilities of the solids are most pure and delicate, and when the fluids and the solids are most perfectly adapted to each other, then also the natural activity and vivacity and sprightliness and buoyant cheerfulness are greatest. (§ 681.) The infant in its mother's lap, delights in the constant motion of its little limbs:—the older child, which is able to run alone, is happy in continual action and laughs aloud with instinctive joyfulness.

§ 687. If this physiological condition of the body could always be preserved, this psychological condition or state of the soul would always remain; and the vivacity and cheerfulness of youth would continue through life. (§ 305.) But the peculiar instinctive activity of childhood and youth has for its final cause, the full and vigorous development of the body. And when this end is effected, neither the organic nor the animal nor the intel-

lectual nor moral wants of man, as an individual or as a social being, require that this instinctive propensity to action should continue equally powerful through life: and hence, with the gradual changes which take place in the development and maturity of the body, (§ 684.) this instinctive propensity to action gradually subsides, till instinct gives place to reason, and leaves the body more to the moral control of the man, to act or rest as the wants and the duties of life require. But, though that exuberance of buoyant vivacity which is the spirit of the youthful instinct to action, with the instinct itself, gradually subsides to the healthful sobriety of manhood, yet much of the serenity and vivacity and cheerfulness of youth may, and ought to be preserved through life.

§ 688. In the best regulated habits and circumstances of life—even if all the physiological laws of the system are strictly obeyed, the change in the relative proportion of the solids and fluids (§ 684.) must necessarily take place, and with that change something of the buoyancy and vivacity of youth will subside into the more serene tranquillity of mature age.—But in such an obedience of the physiological laws of the body, this change will take place very slowly,—childhood and youth will be prolonged,—the period of vigorous manhood will be greatly protracted,—the decline of life will be very gradual,—old age will be free from decrepitude and dotage, and ripe in experience and goodness; and much of the natural activity and vivacity and cheerfulness of youth, will be preserved through the whole of life—even to the latest period of our earthly existence. (§ 786.)

§ 689. Such an old age therefore, is not only desirable to the individual himself, but to society at large; for in it man will not only retain all the physiological and psychological powers requisite for his own calm and rich enjoy-

ment, but all which patriarchal usefulness in society requires. If his bodily appetites have been kept in subjection to physiological and moral truth, (§ 613.) and if his intellectual and moral faculties have been properly cultivated, his bodily powers will be adequate to all the wants and duties of old age,—his natural senses will be little impaired,—his intellectual and moral faculties will be vigorous and active,—the more ardent passions of early life will be chastened down,—the moral man will have become wholly paramount to the animal, and he will have attained to that maturity of wisdom and virtue which makes his last days the happiest period of his life, and pre-eminently fits him to commune continually in spirit with his God, and to exert a sanctifying influence on all around him. The old will reverence his counsels and the young will love his society and his instructions.

§ 690. Such is the old age which God designed for man in his innocence and purity; and such is the old age which man is yet capable of attaining to, and enjoying!—"But whatsoever a man soweth that shall he also reap!—He that soweth to the flesh must of the flesh reap corruption." This is a solemn declaration of what, in the constitutional nature of things, is necessarily true, and therefore is inevitable. By the continued violation of the laws of life, we not only hasten the change in the relative proportion of the solids and fluids of the body, (§ 684.) but yet more rapidly and mischievously effect a change in their *relative conditions*, (§ 685.) developing unhealthy susceptibilities and sensibilities in the solids, and filling the fluid with acrid and irritating properties, and thus rendering them wholly unfit to act on, and to be acted on by each other. By these means all the physiological powers and functions of the body are impaired,—the periods of childhood and youth and vigorous

manhood are greatly abbreviated,—the natural buoyancy and vivacity and cheerfulness of childhood and youth are early annihilated, and depression and sadness and unhappiness take their place; and disease and suffering and melancholy and untimely death invade every hour of human existence: and most of the very few, who, through all these ills and hazards, reach a premature old age at seventy or eighty years, find it a period of feebleness and decrepitude and ailment and cheerless dotage, in which the natural senses are exceedingly impaired or wholly blotted out, and the intellectual and moral powers appear to have sunk into fearful, and perhaps utter decay! and all that remains of the living body is capable of little enjoyment in itself, and is the object of the painful care, and, it may be, the loathing of others.

§ 691. The change in the *relative proportion* of the solids and fluids, (§ 684.) I have said, (§ 688.) must necessarily take place as life advances, even with the most perfect obedience to the physiological laws of the body; and this change may slowly progress in perfect consistency with the best of health, and with scarcely an appreciable abatement of natural vivacity and cheerfulness, from childhood to the latest hours of life. The more slowly and healthfully this change is effected, the more protracted will be the periods of childhood and youth and vigorous manhood, and the more gradual and healthful and happy will be the decline of life, and the more of youthfulness will be carried up through all the stages of our earthly existence. But there is no constitutional necessity for the change in the *relative conditions* of the solids and fluids of the body, (§ 685.) with which the evils I have spoken of (§ 690.) are inseparably connected. By a strict observance of the laws of life, these may be preserved in unimpaired healthfulness

and purity from the commencement of our existence till the vital functions of the system shall falter and their integrity fail from the exhaustion of the constitution in extreme old age. This change, so fraught with ill to man in all respects, is almost entirely the result of his voluntary action. The causes by which it is effected act on him by his own consent, though he may not suspect, or may deprecate the consequences. It may be produced with terrible rapidity and violence, causing the most painful and fatal disease: (§ 1000.) or it may be effected so gradually and by such imperceptible degrees, as to impair all the vital powers and functions of the system, abbreviate the period of life, and bring on a premature old age full of decrepitude and infirmity, without ever being attended with any violent symptoms of acute disease; and too frequently without ever being suspected as the source of evil to the sufferer.

§ 692. Whether therefore, our object be the healthiest and longest life, the happiest old age or the most exalted virtue and piety, it is equally important that, by all means in our power, we should preserve our natural youthfulness and vivacity and cheerfulness with the least possible abatement, during the whole of our earthly existence. (§ 685.) Instead of endeavoring to suppress and subdue the youthfulness of our children and to bring them to staid maturity at twenty years of age, we ought to cherish their youthfulness by every proper means and endeavor to make them young at forty. And this is precisely the precept of Solomon in that passage of Scripture which has been so frequently and so egregiously perverted.* “Enjoy thy youth, O young man!—cherish and preserve the healthful cheerfulness of thy young heart, and be happy in the natural buoyancy and vivacity and sprightliness of

* Ecclesiastes xi. 9.

thy early life!—but remember, in all thy enjoyment, that thou art an accountable being!—that thou art under the natural and moral government of an omniscient, omnipotent, and infinitely wise and just God! (§ 613.) and that thou canst not violate the laws of thy nature with impunity, nor transgress them without evil:—and therefore, at all times carefully refrain from every indulgence and every pleasure, by which thy youthfulness shall be impaired and thy soul depraved: (§ 530.) and withhold thyself from all undue anxiety and labor for riches and honor; and all inordinate ambition and toil for knowledge and for renown; and from every other excess by which thy health will be destroyed and thy cheerfulness blighted and thy spirit broken, and thy life filled with disquietude and suffering and sorrow; and by which thou wilt be prematurely cut off from among the living, or experience a joyless old age, full of decrepitude and despondency and gloom!—For thy Creator is a God of love and delighteth not in thy misery, but in thy happiness:—and thou canst not be permanently happy without a conformity to the laws of thy nature, which he has established in infinite wisdom and benevolence!”

LECTURE XII.

Laws of constitution and relation established in every thing—In the human blood, and all the substances from which it is formed, and which are formed from it—In and between all the organs of the body, and all substances designed for them to act on—Relations of the stomach to all organs and substances in the body—to all alimentary substances without—No organ acts for itself alone—Organs of external relation, primary and secondary—Relations of the eye to light and the visual properties of things—Relations of the organ of smell to odors, &c.—Healthy and unhealthy odors—Depravity of the olfactory sense—Relations of the organ of taste to gustatory properties—The depravity of the gustatory sense—Gustatory enjoyment greatest in those whose dietetics habits are most simple—Anecdote of the epicure—Constitutional relations of the teeth to the organs and substances of the body and to the nature and condition of the food—Constitutional relations of the lungs to the blood, &c. internally, to the atmosphere, &c. externally—Constitutional relations of the stomach to the blood, &c. internally, and to all alimentary substances externally—Its nice organic sensibility—This may be depraved—The consequence of this depravity—Relations of the stomach to the stimulating properties of food—Relations of the stomach to the bulk or proportions of the nutritious and innutritious matter of food—Illustrations—Experiments of Dr. Stark—Relations of the sense of hunger to the internal wants and external supplies—Relations of the sense of thirst.

Laws of Constitution and Relation established in the Human Body.

§ 693. In every part of my general argument thus far, I have endeavored to keep prominently in view the im-

portance of the laws of constitution and the laws of relation, in every form of matter and mode of existence. (§ 140. 144.) And these, I have insisted, are established, not only in wisdom, but in benevolence, (§ 692.) and aim as much at a result of happiness as of utility. (§ 613.) We have seen that all the solids of the human body may be resolved to three general tissues. (§ 156.) The cellular, the muscular, and the nervous; and that, the vital elasticity of the cellular tissue, the vital susceptibility and contractility of the muscular tissue, the nervous and sensorial powers of the nervous tissue, together with the vital affinities which are under the control of the nervous power, constitute the grand elements of power, (§ 312.) by which all the operations of the vital economy are carried on, and all its effects are produced. And these vital properties of the several tissues, in all their delicate modifications, of special susceptibility and organic and animal sensibility, (§ 292.—296.) depend on the constitutional natures of the tissues to which they belong, (§ 140. 142.) and every infraction of these laws of constitution and relation, necessarily impairs in some degree, the vital properties of the tissues, and functional powers of the organs composed of the tissues.

§ 694. We have seen also, that the human blood has a fixed constitutional nature, holding a fixed relation to the substances from which it is elaborated. (§ 142.) As a general statement, human blood can be elaborated from all vegetable and animal substances:—every moving thing that liveth, as well as every green herb or vegetable, can be made meat for man;—but the vital constitution and properties of the blood nicely vary with the varying qualities of the food: and hence the blood holds a fixed and precise constitutional relation to the particular kinds of substances on which man can subsist:—and consequently,

the vital constitution and properties of the blood are more or less perfectly adapted to the final causes of our organization, and to the highest and best condition of human nature, according to the character of the particular substances on which we subsist. If therefore, our food is not what it should be, our blood, as a general and permanent fact, cannot be what it should be.—It is true that, while the assimilating powers of the vital economy are vigorous and unimpaired, a considerable integrity of functional results may be maintained by that economy, for a longer or shorter time, even though the alimentary substances from which it elaborates the blood, are not best adapted to the wants of the system;—yet such substances necessarily in a greater or less degree impair the assimilating powers of the vital economy, and in the end, deteriorate the functional results.

§ 695. Again, each of the solids and fluids of the human system, formed from the blood, has a fixed constitutional nature, (§ 142.) holding fixed and precise relations to the blood, and to each other, so that, if the blood is not what it should be, these cannot be what they should be. The cellular, the muscular and nervous tissues cannot be produced by the vital economy from any thing else than true animal blood, and therefore, each of these tissues has not only a fixed constitutional nature peculiar to itself, but necessarily also, a fixed and precise constitutional relation to the constitutional nature of the blood, and through the blood to the substances from which the blood is elaborated; and as they are all produced by one and the same vital economy from one and the same current of blood, (§ 507.) they necessarily hold fixed relations to each other.

§ 696. The *vital properties* of the tissues (§ 312.) in all their delicate modifications, depending on the consti-

tutional nature of the tissues, (§ 693.) necessarily hold fixed and precise relations to the constitutional nature of the blood:—so that, these properties always nicely vary with the varying character of the blood, and hence, whatever deteriorates the constitutional nature of the blood, necessarily, as a general fact, impairs the vital elasticity of the cellular tissue, the vital susceptibility and contractility of the muscular tissue, and the nervous and sensorial powers of the nervous tissue, in all their delicate modifications:—and on the other hand, whatever impairs the vital properties of the tissues, necessarily, as a general fact, deteriorates the constitutional nature of the blood.—Constitutional relations equally determinate, exist between all the fluids of the system, and between the fluids and the solids. (§ 685.)

§ 697. Such are the laws of constitution and relation which a wise and benevolent Creator has established in, and between all the particular substances of which our bodies are composed: and hence of necessity, the constitutional and functional laws of relation between all the organs of the system, and between each of these and each and all the particular substances of which our bodies are composed, are equally precise and determinate. Thus, the stomach is organized with fixed and precise relations to all the other organs, and to the blood and every other substance of the body: and the *functions* of the stomach necessarily hold fixed and precise relations to the blood, and to all the other substances of the body, and to the functions of all the other organs;—and all this is true of each and every other organ of the system. Each organ has its particular function to perform,—yet no organ can perform its function independently of the others; and no organ can sustain itself by its own function:—on the contrary, each organ exhausts its vital powers and wastes its

substance by the performance of its own particular function, (§ 376.) and is replenished and nourished and sustained by the united functions of the whole assemblage of organs. The alimentary canal, (§ 320.) digests food for the whole system; the lacteals (§ 388.) elaborate chyle for the whole system, and the liver and kidneys and blood-vessels and lungs and skin, perform their functions for the whole system, and therefore *the function of no one organ can be impaired, without involving the whole system in the consequences.* Such is the dependence of each organ upon the whole system, and of the whole system upon each organ:—and such are the fixed and important laws of constitution and relation appertaining to the internal economy of the human body. (§ 297. 298.)

§ 698. But the human body subsists on foreign substances, (§ 209.) or materials which are extrinsic and separated from itself; and therefore it is furnished with organs of external relation, (§ 210.) which are constituted with fixed and precise relations to the constitutional nature of the blood, and to all the other substances of which the body is composed, and with fixed and precise relations to the constitutional nature of the external substances, designed for the nourishment of the body. The primary organs of this class, are the alimentary canal, the lungs and the skin:—and for the supply of the wants of the vital economy, and the protection of the vital welfare, we are furnished with organs of external perception, of locomotion and of prehension. (§ 233.) The organs of external perception are those of touch, taste, smell, hearing and sight.—The organs of locomotion are the lower extremities—or the legs and feet. The organs of prehension are the upper extremities, or the arms and hands.

Constitutional Relations of the Organs of Sight, Hearing, Smell and Taste.

§ 699. The organs of sight, (§ 409. *et. seq.*) are constituted with the most precise and fixed relations to the constitutional nature of light, and to those properties of external things, of which light is the medium of perception: (§ 564.) so that when the organs are in a perfectly normal state, and the light is pure and perfectly natural, we have a perfect visual perception of all external objects to which the eye is directed: but whatever impairs the constitutional nature of the organs, necessarily impairs their visual powers; and the visual perception of external things is commensurately less perfect: and hence whatever impairs the sensorial powers of the nervous system, necessarily impairs our visual powers. (§ 1136.) But we have seen that, there are fixed and precise constitutional relations between all the tissues (§ 695.) and substances of the body, and therefore whatever deteriorates the constitutional nature of any of the tissues of the body, (§ 696.) as a general fact, impairs the visual powers of our organs of sight:—and all this is true of the organs of hearing, smell, taste and touch.

§ 700. The organs of smell (§ 398.) and taste (§ 397.) are more especially the instruments of instinct, employed in the functions of respiration and alimentation, as sentinels on the out-posts of the vital domain.—Every vegetable and animal substance, and many inorganic substances possess specific properties in relation to animal life, and to the wants of the vital economy of animal bodies. Some of these are salutary and some are baneful: and each of these substances imparts an odor to the surround-

ing atmosphere, exactly characteristic of its specific properties. Our organ of smell therefore, is constituted with fixed and precise relations to the constitutional nature of the blood, and other substances of the body,—to the general wants of the vital economy,—to the organization and functional powers of the lungs and stomach, within, and with fixed and precise relations to the qualities of odors, without.—So that, in a perfectly normal and undepraved state of the organ, it detects the qualities of odors with the nicest accuracy; and unerringly discriminates between what is good or salutary for the living body, and what is baneful or injurious.—Physiologists, judging from the depraved condition of the human organs, universally assert that the instinctive power of smell is naturally far less keen and discriminating in man than in many of the lower animals. But this is entirely incorrect.—Reasoning *a priori*, from the nature of things, we should be led to conclusions different from the doctrine of the schools on this subject:—and we know, from the most complete experiment, that were the human species reared, from birth to maturity, in as strict accordance with the constitutional laws of their nature, as are the lower animals in a pure state of nature, the faculty of smell in man would at least equal, and probably far excel that of any other animal, in exquisite delicacy of perception, and in discriminating power, for the instinctive purposes of the system. It would enable us, with unerring accuracy, to select or to avoid instinctively whatever is salutary or baneful—whatever is beneficial or injurious to us, in those qualities of things appreciable by smell. And therefore, the faculty was given to us, not only as a means of enjoyment, but pre-eminently to serve the instinctive purposes of the vital economy, (§ 606.) in detecting the specific

characters of external things in relation to life, by the odors which they impart.*

§ 701. The organ of smell is a sentinel for both the lungs and the alimentary canal. It is of the utmost importance to the vital welfare of the body, that pure air should be constantly received into the lungs at every inspiration of breath; and hence the olfactory nerves are distributed over the lining membrane of the cavities of the nose, (§ 399.) through which the air passes into the lungs; and when in a perfectly healthy and undepraved state, they detect, with the nicest powers of discrimination and integrity of instinct, every odorous property of the atmosphere, which is unfriendly to life; and the animal, being thus informed of the presence of an unwholesome atmosphere, is able to suspend respiration for a very short time (§ 302.) and to hasten from the offending cause.

§ 702. It is not only true that some odors are in themselves baneful to the human body when received into the lungs, in any quantity, but it is also true that odors which are themselves innoxious and delightful when properly diluted with pure air, become exceedingly oppressive and even dangerous to us when too much concentrated, or when the air which we breathe is too deeply freighted with them.—Thus, a person whose system is pure and whose olfactory nerves are perfectly healthy and undepraved, will feel a severe nervous oppression accompanied with more or less pain in the head, flush of the face, quickened pulse, general symptoms of fever attended with chills, and perhaps followed by

* It is a remarkable fact, according to both Soemmerring and Blumenbach, that the organ of smell is smaller in the civilized portions of the human family than in those who are little removed from the savage state.

profuse perspiration, if he breathes for a short time the air which is loaded with the perfumes of a garden of roses and other flowers; or the air of a room containing several pots of geranium.* And therefore, while the natural distribution of flowers and fragrant herbs over the face of the earth imparts a healthful perfume to the atmosphere,—affording us a rich enjoyment in the exercise of our sense of smell, and evincing the goodness as well as the wisdom of the Creator, the cultivating and crowding of large numbers of fragrant flowers and plants together in gardens and houses, is decidedly unfriendly to the physiological welfare of our bodies. So true is it that an infinitely wise and benevolent God has created us with such a nature, and established in our nature such constitutional relations to external things, that, while we have high and healthful enjoyment in the proper exercise of all our faculties and powers, we cannot make the gratification of any of our senses a source of enjoyment beyond the fulfilment of the constitutional purposes for which those senses were instituted, without jeopardizing all the interests of our nature and finding disease and suffering in our pursuit of happiness.

§ 703. But some will say that, such an exquisitely delicate power of smell is far from being desirable;—that they would not wish to possess such keen olfactory sensibility as to feel oppressed and pained by the rich fragrance of a flower garden, and the delightful breath of the domesticated geranium. Yet let them remember that, by divesting themselves of this sensibility, they do not alter the constitutional relations between the odors which they breathe and the vital properties and interests of their

* Many individuals have died suddenly in consequence of inspiring the too powerful perfume of roses and other fragrant flowers accumulated in large quantities.

bodies!—Whether the olfactory sentinel which a wise and benevolent God has placed on the outposts of the vital domain, performs with strict integrity the duties for which it was placed there, or not, still the properties which the inspired air carries into the lungs are equally salutary or baneful to the vital interests of the body.—Let them remember also, that by divesting themselves of that exquisitely delicate sensibility of the olfactory nerves, which renders them unable to inhale the air that is too deeply loaded with the fragrance of a flower garden without oppression and pain, they thereby necessarily divest themselves of that nice olfactory power, with which God has endowed them, to discriminate instinctively between salutary and poisonous odors and substances.—Thus, like the rebellious Israelites in the wilderness, they drive away that spirit of truth with which God had endowed their organs, to guide them in the way of life and health and happiness, and yielding themselves up to their sensualities, they sink deeper and deeper in depravity, till they learn perhaps to find their greatest delight in breathing the most poisonous odors of the vegetable kingdom; and receive their deadliest enemy into their bosoms as their dearest friend, without the slightest suspicion of their danger; and millions perish with every form of disease and suffering, cherishing with unbounded confidence to the last moment, as their most tried friend and greatest comforter, the very enemy that thus treacherously destroys their lives.—It were infinitely more wise then, to cherish the strictest integrity of those sentinels which God, in wisdom and in goodness, has established for the protection of our vital interests, and to obey their holiest dictates and shun or remove whatever offends them, than to destroy their integrity, that we may feel secure in the presence of our enemies, and revel in unsuspecting confidence in the midst of danger.

§ 704. Besides thus acting as sentinel to the lungs, to protect them from impure air, the organ of smell, as I have stated, (§ 701.) is also, in its perfectly healthy and undepraved state, a sentinel to the alimentary canal, (§ 294.) and enables us instinctively, with unerring accuracy, to discriminate between those substances which are salutary and proper for our nourishment, and those which are poisonous or unsuitable to be introduced into the stomach.* But this sentinel may be so depraved as to lose its discriminating power, and be no longer able to detect the baneful qualities of things, and thus become wholly unfitted to answer the instinctive purposes of the system. Indeed, it may become so excessively depraved as entirely to lose the power of appreciating odors; in which case the organ will only retain the ability to appreciate the degree of stimulation, without the least power to appreciate the quality of the stimulus.—Thus, snuff-takers always exceedingly deprave the sense of smell, and greatly impair, and often wholly destroy its power of discriminating between odors of the most opposite character; and in some instances the power of smell is completely destroyed, and the organ only retains the ability to appreciate the stimulation of the most powerful stimuli. In such cases, the parts to which the stimulus is applied, and those which are associated with them, become so accustomed to, and so dependent on the

* “Without the aid of smell, the sense of taste would be very vague in its indications and limited in its range,” says Professor Roget, and such is the prevailing opinion of physiologists; and yet Mr. Hill, who has not been able to smell even the most pungent odors for the last ten years, (see Note to § 573.) assures me that his sense of taste remains good and nicely discriminating in all gustatory qualities; but he finds, since he lost his smell, that he used often to confound gustatory with olfactory perception in his mind, and suppose he tasted qualities which in reality he smelt. This is undoubtedly a common error.

artificial stimulus for their wonted excitement, that the natural and appropriate stimuli of the system are wholly inadequate to save them from that deep and distressing prostration which necessarily results from their habitual and shocking debauchery; and therefore, they become exceedingly eager, and even vehemently importunate in their demands for the artificial stimulus, and will not be pacified without it. Hence the power of such habits, and the great difficulty of breaking them up.

§ 705. To preserve the natural purity and functional powers and integrity of the organ of smell, and to prevent the depravity which I have described, the sensibilities of the organ and the sympathies of the system unite to resist the encroachments of all depraving and offending causes.—Numerous filaments of the trifacial nerve (§ 254. 255. 256.) are distributed over the lining membrane of the cavities of the nose, where they are intimately associated with the filaments of the olfactory, or special nerve of smell.—The olfactory nerve possesses no sensibility except that which perceives odors. The common sensibility or feeling of the nasal cavities therefore, is wholly the property of the filaments of the trifacial.—These filaments have not in the slightest degree the power of perceiving odors: but so intimately connected in anatomical arrangement and functional relation are they with the olfactory nerve, that their healthy sensibility cannot be impaired without detriment to the sense of smell, and jeopardy to the whole system.—Hence, when any substance comes in contact with the lining membrane of the cavities of the nose, which is of a nature to impair the sense of smell, to injure the lungs, or to impair the vital properties of the trifacial nerve, or in any manner to jeopard the interests of the vital economy, the trifacial nerve instantly feels the pres-

ence of the substance, and the membrane is excited to an increased secretion of mucus to shield the parts (§ 339.) from its poisonous or irritating properties; and if the offending cause is of such importance, either in quality or quantity, as considerably to endanger the system or the parts on which it acts, the trifacial nerve immediately gives a sympathetic alarm, which is instantly diffused over the domain of organic life, (§ 225.) and the instinctive powers of the system are at once called up to expel the invading foe. A deep, full breath is inhaled, and then the arch of the tongue is raised and pressed against the veil of the palate so as to prevent the air from passing out at the mouth—and the diaphragm, and the abdominal muscles which draw down the breast-bone and ribs, are suddenly and powerfully contracted, and the air of the lungs is violently driven out through the cavities of the nose for the purpose of expelling the offending cause.

§ 706. Thus, if a person with a pure system and undepraved olfactory nerves, comes into the vicinity of a large quantity of tobacco, he instantly perceives the loathsome odor and at once detects its poisonous character, and finds himself urged by many distressing feelings to avoid the deadly narcotic:—but if, regardless of these admonitions, he thrusts some powdered tobacco into his nose, his olfactory nerve still perceives and appreciates the poisonous odor, and the trifacial nerve feels the poisonous character of the irritating substance, and gives the alarm to the domain of organic life, and violent sneezing soon ensues as the instinctive means of expelling the offending cause.—If the offending cause is not removed by sneezing, the whole system soon becomes so much affected by the poison that the most distressing dizziness, and muscular relaxation and tremor

and sickness at the stomach, and cold sweat, and vomiting and convulsions follow in rapid succession, in order both to expel the poison from the vital domain, and to cause us ever after, more cautiously to avoid so deadly and so foul an enemy.—But by commencing this career of depravity with cautiously measured steps at first, we may in time, succeed in utterly destroying the integrity of this important sentinel, and so completely deprave both the olfactory nerve, and the nasal portion of the trifacial, that, neither of them can any longer detect the poisonous character of the tobacco; but both of them will become so adapted to its properties, as to delight in its stimulation, with an intensity of morbid enjoyment equal to the depth of depravity to which they are reduced.—And thus the organ of smell, instead of guarding the vital domain like a true and faithful sentinel, against the encroachments of every enemy which it is naturally qualified to detect, not only ceases to give alarm to that domain when those enemies are approaching, but even throws open its gate and earnestly entreats those enemies to enter; and embraces the foulest and the deadliest of them all as the dearest and most valuable friend, and ushers it into the vital domain, proclaiming with inebriated energy the introduction of a generous and glorious conservator. And thus, by sensual depravity, we transform a guardian angel of light into a treacherous demon of darkness; and still confiding in its integrity and fidelity to the vital domain, we receive into the very citadel of life the enemy which poisons all our wells of vitality, and with perfect infatuation rejoice in his destructive influence, and regard his withering embraces as the source of our highest enjoyment, and perish in the full belief that our destroyer is our truest friend, and perhaps, with our dying breath

commend him to the confidence and kind regard of all around us.—Such are the natural consequences of disregarding the holiest and most delicate admonitions of those undepraved sentinels which a benevolent Creator has, for the preservation of our highest welfare and happiness, placed on the outposts of the vital domain. There is indeed a sense, in which it may be said, that sneezing is the voice of God in our nature, distinctly and unequivocally commanding us to avoid whatever causes us to sneeze. And let it ever be remembered, that although the constant application of snuff and other poisonous and pernicious substances to the lining membrane of the cavities of the nose, may so deprave the tissues of that membrane, and so impair their delicate and peculiar sensibilities, that they can no longer discern between good and evil—and no longer detect the poisonous qualities of those substances, nor give the alarm of danger to the vital domain, by which sneezing and other instinctive efforts are called up to expel the offending cause, yet the real character of those substances, and their true relations to the vital powers and interests of our bodies, remain unaltered, and equally hostile to our life and health and happiness.

§ 707. Most of the principles which I have now stated and explained, in regard to the faculty of smell, are also true concerning the faculty of taste. (§ 254. 397.) Every foreign or external substance which the human body has power to derive nourishment from, possesses a specific nature which holds a fixed and precise relation to the constitutional nature of the human blood (§ 694.) and all the substances of the body (§ 695.) and to the general interests of the vital economy:—and each of these foreign substances has certain properties essential to its specific nature, and exactly characteristic of its relations to our

living bodies, as a nutritious substance; and which we have not the least power to perceive by our sense of sight, hearing, smell nor touch. But God has endowed us with the special sense of taste, which is adapted with infinite wisdom and benevolence to those properties of nutrient substances, and by which we can detect and appreciate and discriminate them with the nicest and most delicate accuracy: and hence, there are between our organ of taste and the constitutional nature and gustatory properties of substances intended for our nourishment, the most fixed and precise constitutional laws of relation: and necessarily therefore, there are equally fixed and precise laws of relation between the organ of taste and the constitutional nature of our blood and other substances of which our bodies are composed.—The organ of taste then, is a most important sentinel of the alimentary canal; and its office is to perceive and appreciate the gustatory properties of all the substances received into the mouth for the nourishment of the body, and nicely to discriminate between what is salutary for the body and adapted to the alimentary wants of the vital economy, and what is pernicious or offensive.—And when the system is pure and the organ of taste is in a perfectly normal and undepraved state, its perceptive and discriminating power in man, is equal to, if not greater than that of any other animal; (§ 19.) and man may be instinctively guided by it in the selection of his food (§ 425.) with unerring accuracy and safety. (§ 606. 607.)*

* It is a prevailing opinion that man, being endowed with reason, required and received from the hands of his Creator, a much less nicely discriminating power of taste and smell, than many, and perhaps most of the animals below him. But this notion is wrong both in fact and philosophy.—Suppose God were to create a full-sized man and endow him with the highest order of reasoning faculties, and place him in some portion of the earth uninhabited by the human race and in

When the organ is in this state of integrity, if natural substances pernicious to life, or those which are not adapted to the constitutional wants of the body, are received into the mouth, their offensive character is instantly detected, a loathing is soon felt, and mucous and salivary secretions are poured into the mouth to shield the parts acted on, (§ 339.) and to flood the offending cause from the porch of the vital domain.—If the character of the offending substance be such as to render it exceedingly dangerous to the vital interests, or such as is wholly unfitted for the highest and best condition of our nature, the loathing will be so intense as powerfully to urge us to expel it from the mouth; and if we do not promptly obey this admonition, the sympathetic alarm will be diffused over the whole system, by the same means and in the same manner as in the nose, (§ 705.) and dreadful nausea and dizziness and muscular relaxation and tremor and cold sweat and violent vomiting will ensue, as the instinctive means of the vital economy

the midst of every variety of mineral and vegetable and animal substances. Could that man's reason tell him what to eat?—or in any manner determine what is salutary and what is poisonous? Not one whit better than his hand could!—If he did not possess nicely discriminating powers of instinct to guide him unerringly to his proper food, he would, with all his rational faculties, be as likely to select a poisonous as a salutary substance: for it would not be possible for reason to ascertain the qualities of any substance with reference to his alimentary wants.—But having been once guided by instinct to his proper food, and having by experience found it to be good, his reason would then enable him to select the same food again and to take measures to secure a supply of it.—Man therefore, is naturally as entirely dependent on instinct, in the original selection of his food, as any other animal; and in the pure state of his nature, as it came from the hands of his Maker, possesses as nicely discriminating powers of taste and smell as any earthly being. And nothing is more erroneous and absurd than the claims that are set up for the dietetic and other privileges of man on the score of his *reason*.

to relieve itself from danger.—But by habitually debauching the gustatory nerve and the other tissues of the mouth, with poisonous or improper substances, we soon destroy the power of the organ to discriminate between salutary and pernicious substances, and the power of the parts to give the necessary alarm and call up the necessary efforts of the system, to protect itself from danger; and in a short time, the tissues of the mouth become so deeply depraved, and so completely conformed to the qualities of these improper substances, that they learn to delight in their stimulation, incomparably more than in that of healthful and proper substances:—and thus, by destroying the integrity of this sentinel, we are given up to believe a lie.—Improper substances are received into the vital domain, with more or less repugnance of the instinctive powers at first, according to the character of the substances and according to the caution or excess of our incipient transgressions, till the depravity is extended from the mouth through the whole of the alimentary canal: and the mouth and stomach not only become reconciled to, but exceedingly delight in the character and influence of the most pernicious substances,—which either with hasty ravages spread ruin over our whole vital domain, and violently precipitate us into the grave, or slowly and treacherously sap the foundations of our constitution and fill us with disquietude and feebleness and disease, which terminate in untimely death:—and still we, with the utmost confidence in the integrity of those organs, strenuously contend for the rectitude and safety of our course, on the ground that it is pleasant to the taste and agreeable to the stomach. Indeed, these organs may become so thoroughly depraved, that they will reject the most salutary substances, as disgusting and pernicious; and receive the most pernicious substances as agreeable and salutary.

§ 708. In a healthy and pure condition of the system, when the organ of taste is in a perfectly normal and undepraved state, if substances designed by our Creator for our aliment be brought, in the best and most appropriate condition, in contact with the organ, the gustatory qualities of the substances will afford us the highest degree of gustatory enjoyment, which it is possible in the nature of things for the same substances to yield. Thus, if a perfectly ripe strawberry or peach or any other kind of fruit be received into the mouth and masticated, our gustatory enjoyment, if our organ of taste is healthy and undepraved, will be as great as the qualities of the particular substance can make it. We cannot by any confectionery process, make the qualities of the ripe strawberry more delicious. We may, it is true, by such processes, combine other qualities with those of the strawberry, and make a compound dish which will be more agreeable to some; but in such a case the increased enjoyment will be derived not from an actual improvement of the qualities of the strawberry itself, but from the addition of other qualities. So that, it still remains true, that there is between our organ of taste and every substance which may properly be received into our stomach, such fixed and precise constitutional laws of relation, that each particular substance has a specific savor, which, when the substance is received into the mouth in that condition which is best adapted to our organization and vital wants, and properly masticated, will impart to us the highest degree of gustatory enjoyment that it can be made to afford.—And as it is the instinctive office of the organ of taste as the sentinel of the stomach, to perceive and appreciate these specific gustatory properties of alimentary substances, with the nicest accuracy of discrimination, in order to secure the strictest fulfilment of the laws of relation between the constitu-

tional nature of our blood and other bodily substances, and the constitutional nature of our food, (§ 694.) we have, in a pure state of the system and undepraved state of the organ of taste, a delicate and highly grateful variety of gustatory enjoyment, equal to the natural variety of substances which a benevolent God has bountifully prepared for our nourishment. So that, the more simple our diet and the more conformable it is to the constitutional laws of our nature, the more we not only promote health and healthful enjoyment generally, but also, gustatory enjoyment of the purest and the highest kind; for then we find in every proper article of food, a new and delicate savor, and often an exquisite relish; and even pure soft water, which most men consider tasteless, and many think insipid, has a deliciousness to such a pure organ of taste, wholly unknown and inconceivable to those whose gustatory powers have become depraved by artificial habits.

§ 709. Thus our benevolent Creator, in subjecting us to the necessity of constantly nourishing our bodies with foreign substances, has constitutionally connected that necessity with animal as well as moral powers of enjoyment, and bountifully supplied a rich variety of means for the appropriate exercise of those powers. But inseparable from these constitutional capabilities for good and happiness, are equal capabilities for evil and misery: for these very powers of enjoyment, which, while preserved in their purity and integrity, and exercised in conformity to the constitutional laws of our nature, always promote the highest and best condition of that nature, yet when they become depraved and their integrity is destroyed, and they are habitually exercised in the violation of the constitutional laws of our nature, become the ministers of disease to our whole nature and of untimely death

to our bodies.—And hence the common maxim, that what is agreeable to the palate and sets well upon the stomach, is nourishing to the body and conducive to health, is strictly true, while the purity and the perfect integrity of our organs are preserved, but fatally fallacious when our organs are depraved, as is universally the case in civic life, and almost universally the case throughout the human world.

§ 710. With the organ of taste, as with that of smell, many qualities which are grateful and salutary when received in that condition in which God in nature has prepared them for us, become depraving to the gustatory power and oppressive and injurious to the system when too much concentrated by artificial means. Thus the acid and the sweet properties of nutritious fruits and vegetables, are exceedingly grateful and salutary as they are naturally found in those fruits and vegetables; but when freely and habitually used in concentrated forms, they impair the power of the organ of taste to perceive and appreciate other gustatory properties and to discriminate between the salutary and the pernicious, and become the causes of oppression and disorder to the digestive organs and of disease to the whole system.

§ 711. It may therefore, be laid down as a general law, that precisely in proportion as we become accustomed to the use of any one substance which has a strongly depraving gustatory property, the power of our organ of taste to perceive and appreciate other gustatory properties, and discriminate between the salutary and the pernicious, is impaired, and our gustatory perception and satisfaction become limited to that one depraving quality. Thus the habitual tobacco-eater and spirit-drinker always exceedingly impair their gustatory powers, so that, their gustatory perception and satisfaction become almost en-

tirely confined to their tobacco and spirits: and frequently those who habitually indulge in these vile poisons to great excess, entirely destroy their powers of taste, and are only able to appreciate the degree of stimulation produced by their favorite substances. Such individuals eat to sustain their bodies or to answer the demands of their stomachs; but they have no more gustatory enjoyment in eating than they would have if their mouths and throats were lined with copper.—All high seasoning upon food produces a similar effect, though seldom to an equal extent:—and indeed, all artificial stimuli and most artificial preparations of food, in their different measures, produce similar effects on the organ of taste, and thus impair its power and destroy its integrity as an instinctive sentinel of life, which God has placed at the most important outpost of the vital domain!

§ 712. Those, therefore, who seek for gustatory enjoyment in the artificial preparations of culinary skill, defeat their own object; for they, as a general fact, necessarily diminish their gustatory enjoyment by such means, and circumscribe it to narrower and narrower limits, in proportion as they depart from that simplicity which is required by the constitutional laws of their nature.—Nor is this important doctrine any the less true because they who are deeply sunken in gustatory depravity, cannot be convinced of its truth while they remain in their depravity.—The following statement of a real case, which took place at one of the principal hotels in the city of New York, during the summer of 1831, is a good illustration of the principle I have just advanced. The dinner-hour arrived, and the table, fitted for more than a hundred persons, was richly furnished, with every variety that the markets could afford, prepared and served up with the utmost exercise of culinary skill. The

bell was rung, and the table was soon surrounded by those for whom it had been prepared.—Some, of simpler habits and less depraved palates than the rest, selected the plainest and simplest articles of food before them, and made their repast with much gustatory enjoyment.—Others, of a more omnivorous character and miscellaneous appetites, partook freely of almost every dish within their reach, and ordered supplies from many that were not within their reach. These, without any distinct gustatory perception of the specific properties of the different substances which they devoured, yielded to the morbid cravings of their stomachs and eagerly gorged themselves, with a kind of indistinct and promiscuous satisfaction.—But there was one gentleman at the table of no plebeian palate. His gustatory faculty had been educated to the very top of its capabilities. He was, in the modern sense of the term, an epicure of the highest order. He lived for the enjoyments of the palate, and had systematized eating and drinking into the most refined art.—He took his station at the head of the table. Before him smoked a well cooked sirloin of roasted beef. He carved it in the most skilful manner, and after having served others, he helped himself to a delicate bit, and sat down and dressed it with a variety of seasonings, and then tasted of it—but it afforded him no relish.—He called a waiter, and ordered his plate to be changed, and a dish of calf's head and feet to be brought to him, from another part of the table. A portion of this dish was taken upon his plate and nicely seasoned and tasted. This he found not to be properly cooked;—and the waiter was again ordered to change his plate and bring him a dish of fowls:—these had been mangled in carving, and were ordered back untouched.—The raw gizzards of the fowls were then ordered from the kitch-

en;—these were carefully dressed by the gentleman, well basted with the contents of the caster, and the waiter received particular instructions how to have them broiled. This being done, and the gizzards again before the gentleman upon the table, they were again profusely basted with butter and the contents of the caster:—cayenne pepper was freely showered upon them, and mustard in abundance. The gentleman then tasted of the gizzards, and found them to relish so well that he concluded to make his dinner of them.—In the mean time however, the other gentlemen at the table had finished their first course, and the waiters were removing their plates. Our epicure, unluckily, at this moment laid down his knife and fork and pushed his plate a little aside to take a glass of wine, to give tone to his stomach. When he had drunk his wine, he turned to commence his dinner, but his gizzards were gone! He called aloud to the waiter,—but it was too late—the gizzards, saturated and swimming as they were, in a purgatory of grease and pepper and mustard and other fiery condiments, had been scraped with ruthless hand, into the common mass of the ruins of the table!—and the the unfortunate epicure was compelled to make out his dinner the best way he could.—Now, what could have been the gustatory enjoyment of such a man, who could find nothing upon that sumptuously furnished table from which his depraved palate could derive enjoyment, and who could only find satisfaction in such a dish as he prepared for his repast? The gizzards themselves, in the first place, had little more gustatory virtue in them than a cast-off heel-tap of a worn-out shoe;—but if they had possessed any natural savor of a grateful kind, surely the dressings must have completely destroyed it, and left nothing for the organ of taste to appreciate but the gus-

tatory qualities of the fiery seasonings!—A man with a pure system, and with an undepraved organ of taste, might have sat down beside him and dined upon a piece of good bread and a cup of cold water, with a thousand fold more gustatory enjoyment, than it is possible for such an epicure to derive from any dish which culinary art can produce. For the deeply depraved organ of taste in such an epicure has “no virtue to perceive the beauty of truth;”—it has no power to detect the delicate, intrinsic qualities of things, and therefore, whatever may be the article of food, the gustatory enjoyment of such a man, cannot depend on the natural savor of the nutritious substance, but either solely on the gustatory qualities of the fiery seasonings, or, in the total obliteration of the gustatory power, the seared palate is only capable of appreciating the degree of stimulation.—So in the religious world. People whose sympathies exceed their knowledge, and who are more accustomed to be excited than to be instructed, soon come to mistake their mere excitements for the genuine influences of the spirit of truth; and can only appreciate the degree of stimulation, without any power to discriminate as to the quality of the stimulus:—and therefore, their hope and their confidence and their rejoicing are always equal to the degree of stimulation which they feel.—Such have no distinctness nor soundness nor stability in their faith,—their religion rises and falls with their emotions, and they are ever ready to be led away by whatever produces the most powerful stimulation. But they who receive and obey the truth in the love of it, have hope and confidence and rejoicing always in proportion to the distinctness of their perception of, and the fulness of their conformity to the truth.

§ 713. It is therefore, a general law that the more per-

fectly our dietetic habits conform to our laws of constitution and relation, the greater is our gustatory enjoyment, and the more certainly we secure life, health and happiness. This law is established by physiological science, and confirmed by the experience of thousands even at the present day.

Constitutional Relations of the Teeth.

§ 714. The teeth, though possessed of no sensibility by which we detect and appreciate the qualities of our food, are nevertheless, exceedingly important organs of internal and external relation. The manner in which they are produced by the vital economy, has been fully described, (§ 323.—328.) and also their liability to disease and decay. (§ 519.) There are few parts of our whole system, the disease of which is attended with more excruciating and intolerable pain than that of the teeth;—and thousands of human beings, when severely suffering the tooth-ache, have been heard to question the goodness and the benevolence of the Creator, because they have conceived that such suffering in the creature is irreconcilable with those attributes in an almighty and infinitely wise God: but such sentiments evince as much ignorance as impiety in the sufferer. For it only requires a correct knowledge of the constitutional nature and relations of the teeth, to convince every rational creature, that even the excruciating pain itself, which attends the disease of our teeth, is a most conclusive demonstration of the benevolence and goodness of our Creator.—God gave us our teeth for good and only for good:—and so far as the constitutional laws which he has established in our nature are obeyed, we are subject to no suffering from the teeth.—The gradual growth of our bodies from our infantile forms

to sturdy manhood, renders it necessary that our little jaws should be furnished with a set of teeth in childhood, which are too small to fill up our jaws when our system is fully developed, and too small to answer the purposes of mastic tion through life: and hence the wise and benevolent Creator has established a special economy in our system, (§ 325.) by which the first teeth, of our childhood, are in due time removed, and they are gradually replaced as our jaws become more and more developed by a set of permanent teeth, which are much larger and better fitted for the purposes of mastication. But in all this there is, in the original constitution and condition of man, no necessity for the slightest disease or suffering. Were the human species uniformly and permanently to obey the constitutional laws of their nature, the first set of teeth would be produced, and, in proper time, give place to the second or permanent teeth, without the slightest pain or inconvenience in any case. But God has not placed the permanent teeth in our jaws to be removed, and therefore he has made no arrangement in the vital economy of our system for their removal without pain.

§ 715. The teeth are organs of very great importance to the vital interests of our bodies, and their importance continues while the alimentary functions of our bodies are requisite. Most people regard the loss of a tooth as an evil, mainly because of the pain which attends the loss,—some because of the disadvantage to their appearance, and some because of the inconvenience in speaking; but few, if any, regard it as an evil because of the importance of the tooth to the vital interests of the body. But God, who, in infinite wisdom and benevolence, has constructed the whole organic machinery of our bodies, and who perfectly understands the importance of each particular part of that machinery to the general interests of the whole,

as a single system, knows that a single permanent tooth cannot be lost without crippling in some degree the powers of the vital constitution, and in some measure abridging the period of our bodily existence: and therefore, he has constructed our permanent teeth of such materials and in such a manner, and planted them so firmly in our jaws, that they are capable of remaining perfectly sound and healthy, and of performing their proper functions with utmost integrity, from the period at which they are produced, till our vital constitution is worn out, and we die a natural death, at a hundred, or two hundred or five hundred or a thousand years of age:—and because it is of very great importance to the vital interests of our bodies, that the permanent teeth should thus remain in our jaws during our whole life, God has, in wisdom and benevolence, so fixed them there, that they cannot be removed by disease nor torn out by violence without the most excruciating and dreadful pain.

§ 716. The teeth are constituted with fixed and precise relations to the blood (§ 142.) and all the particular substances of the body; (§ 695.) to the nerves, to the gums, to the organ of taste, to the salivary glands, to the stomach and intestinal tube, and to the whole vital constitution and economy:—and they are constituted with fixed and precise relations, to the nature, qualities and condition of those substances which God has designed for human aliment:—and if their laws of constitution and relation be strictly obeyed and never violated, the teeth will never decay nor become diseased nor painful in the human head. In this statement however, I do not mean to affirm that, the present generation of mankind, with all the disadvantages of their own and their parents' transgressions, could, by the strictest conformity to the laws of their nature, wholly redeem themselves from their physical depravities

and predispositions, and preserve their teeth free from disease and pain as long as they live. The teeth are among the last organs which manifest either the deteriorations, or the meliorations of the vital constitution:—hence some people, with excellent teeth, may habitually violate the constitutional laws of their nature in such a manner as is calculated to destroy their teeth, and yet die at what we call an advanced age, with sound teeth in their jaws:—but their iniquities will surely be visited upon their children and grandchildren;—so that, if the same habits be continued, the third or fourth generation, at farthest, will be afflicted with miserable teeth. And on the other hand, people with teeth strongly predisposed to decay, may most rigidly observe the constitutional laws of their nature, without being able wholly to preserve their own teeth from disease and pain; yet they will preserve their own teeth a very great deal longer than they would otherwise last, and they will suffer comparatively little pain from their decay; and if these habits are persevered in by their posterity, the third or fourth generation, at farthest, will have excellent teeth;—and thenceforward to the end of the world, if the laws of constitution and relation are strictly obeyed and never violated by the race, their teeth will never decay nor become painful. It is therefore entirely from the voluntary transgressions of mankind, and not from the want of benevolence in our Creator, that we suffer tooth-ache.

§ 717. But it is asserted that, God could either have made the teeth in such a manner that they could not decay, or that their decay would not be attended with pain. I reply that, if this be true, and if God had so made them, he would have disregarded the best interests of the human system, and neglected to establish one of the most powerful barriers to those voluntary transgressions which

destroy the body. For such is the constitutional nature of the blood (§ 142.) and all the other substances of the living body, and such are their constitutional relations, and the relations of all the alimentary organs, to those foreign substances which God designed for our nourishment, (§ 698.) that those laws of relation cannot be violated without injury to the vital interest of the body, and they cannot be habitually transgressed without causing bodily disease and suffering and death. And such is now the constitutional nature of the teeth, (§ 716.) and *their* constitutional relations to the blood, and all the other substances of the body, and all the alimentary organs, and to those foreign substances intended for our nourishment, that the constitutional relations of the blood and other substances of the body and of all the alimentary organs to those foreign substances, and the constitutional relations of the teeth to those foreign substances, perfectly harmonize, so that, a perfect fulfilment of the constitutional laws of relation in regard to the teeth, is precisely what the best interests of the whole organization and vital economy of the human body require. Precisely that kind, quality and condition of alimentary substances, which the best interests of the teeth require, are also, in the highest degree, conducive to the best interests of the whole vital domain: and on the other hand, every infraction of the constitutional laws of relation in regard to the teeth, is necessarily, in some measure, an infringement on the particular and general interest of the body.

§ 718. In pure benevolence therefore, God has so constituted our teeth, that the transgression of their laws of constitution and relation shall cause them to become diseased and painful, for the sole purpose that the pain shall induce us to refrain from those transgressions, which not only cause the disease and destruction of the teeth,

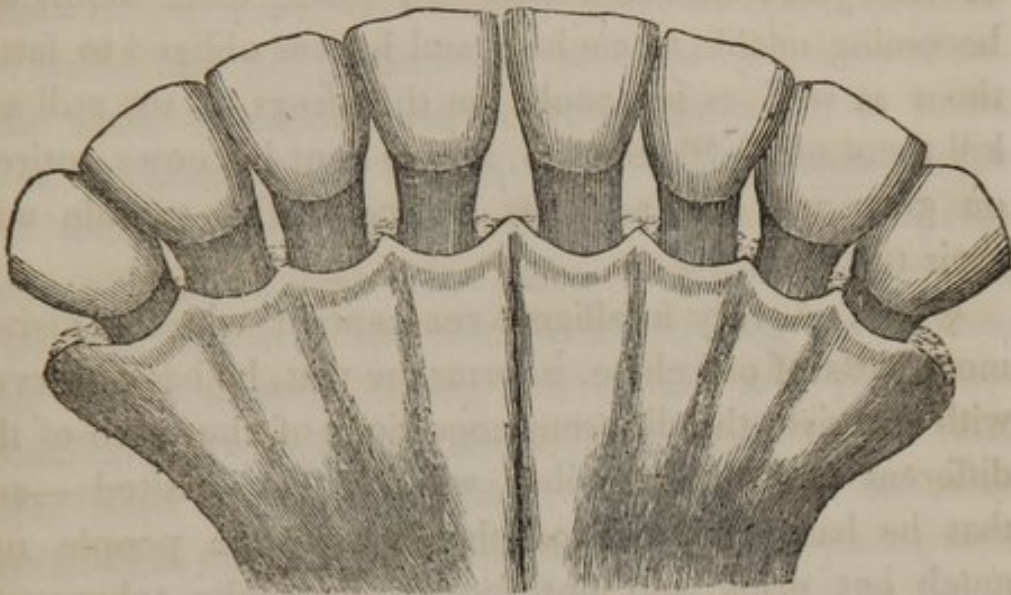
but also lead to the disease and destruction of the whole body. And thus hath God in goodness ordained the tooth-ache as a means of restraining us from destroying ourselves, and of preserving the highest and best condition of our whole nature,—just as he hath ordained that the pain which we suffer when we burn our flesh shall restrain us from running into the fire: and on the same principle of benevolence hath he ordained all the pain that human nature suffers, that we may be kept from transgression and be partakers of his holiness and happiness:—and the excruciating pain which attends the disease of our teeth, and the dreadful violence attending the extraction of them, show the importance of our teeth to the vital interests of our bodies, and of our duty to preserve them.

§ 719. Our teeth were formed to cut and grind our food preparatory to swallowing and digestion; (§ 328.) and every artificial substitute for their legitimate use, is more or less an infraction of their laws of constitution and relation, and necessarily results in commensurate injury to themselves and to the whole system. But when the function of the teeth is correctly and fully performed, on precisely the right substances in precisely the right condition, the laws of constitution and relation are obeyed and the most healthful condition of the teeth is preserved. Almost all artificial preparations of food therefore, and especially those connected with the use of fire, are necessarily more or less injurious to the teeth, and cause them to become diseased and painful.

§ 720. The lower orders of animals in a pure state of nature, whose food is never subjected to artificial preparations, never have accumulations of tartar upon the teeth, nor are their teeth in any way diseased. But the horse, cow, dog and other domesticated animals, which

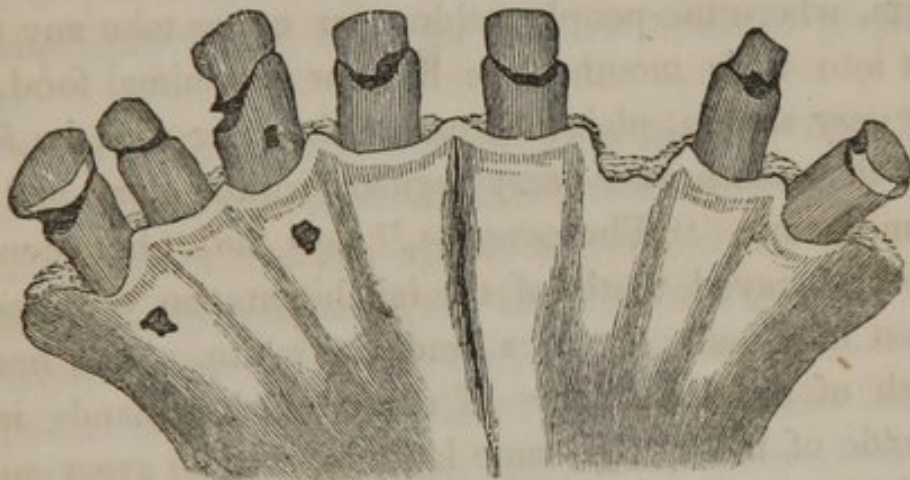
are fed on artificially prepared food, often suffer from calcareous incrustations and decay of teeth; and this is particularly the case with such as are fed on warm and soft food.—Mr. John Burdell, surgeon dentist, of New

Fig. 53.



The teeth of a cow fed on grass and hay.

Fig. 54.



The teeth of a cow of about the same age, fed on still-slops:—
the enamel is destroyed and the bone diseased.

York, who has given much attention to this subject, assures me, he has always found that the teeth of cows fed on warm "still-slops" are very much incrustated with tartar:—and in many instances the enamel is entirely de-

stroyed. (Figs. 53. 54.) This same gentleman informs me that a milk-man who keeps a large number of cows, told him that he once undertook to feed his cows entirely on warm still-slops, and at first, thought it an excellent manner of keeping them; but he found, in the course of three or four years, that they were all losing their teeth, and becoming unable to eat hay, and he was obliged to fatten them as well as he could on the dregs of the still and kill them off.—Since then, he has kept his cows entirely on grass and hay, and has had no further trouble with their teeth.

§ 721. A very intelligent sea-captain who has visited most parts of our globe, informs me that, he has observed with surprise, the different conditions of the teeth of the different nations and tribes which he has visited:—and that he has always found that, where the people use much hot drink and hot food, and smoke tobacco or other narcotic substances, their teeth are black and much decayed; and that in the islands of the Pacific and other parts, where the people seldom or never take any thing hot into their mouths, use little or no animal food, and are very simple, plain and natural in their diet, he found that their teeth were very regular, white, clean and free from decay. “The contrast,” says he, “between the black, decayed teeth of the inhabitants on the western coast of South America, and the white, clean, healthy teeth of the inhabitants of some of the islands in the Pacific of nearly the same latitude, was so great and so striking as to excite my astonishment.”

§ 722. A medical gentleman who formerly spent fifteen years in one of the remote counties of the State of Maine, where the principal business carried on, was that of getting out lumber; and where the inhabitants, with active, industrious habits, knew nothing of luxury, but

subsisted on a plain, simple and coarse diet, stated that, the people were very remarkable for their fine, white and regular teeth, which were wholly free from decay; and that, although he was the only physician in the whole county, he had occasion to extract but one tooth in the whole fifteen years; and he finally left the parts because he could find no professional business to attend to.—The same freedom from decay of the teeth is found in all portions of the human family, in the same simple and temperate circumstances and habits. The peasantry of Ireland, and other parts of Europe generally, who are free from the use of intoxicating substances, and whose dietetic habits are simple and plain, are remarkable for their fine, healthy and regular teeth. But facts need not be multiplied. Nothing can be more certain than that most artificial processes of preparing food are injurious to the teeth. (§ 719.) Indeed, so far as these organs are considered, it is unquestionably true, that, a perfectly natural state of our food, would be incomparably better than the present artificial preparations.

§ 723. Culinary preparations, as a general fact, lead us to masticate our food too little, to swallow it too fast (§ 426.) and to eat too much: and these are all very serious evils in relation to the teeth, to the stomach and the whole alimentary apparatus, and indeed, to the whole vital economy. By eating our food in a natural state, or with that artificial preparation which still requires the full performance of the function of the teeth, we avoid all these evils and preserve the teeth in health.—The healthful effect on the teeth, of a regular and full performance of their natural function, is very much greater than is generally supposed. Let any one of ordinary habits of living, who has a full set of sound teeth, accus-

tom himself to masticate his food freely on one side of his mouth, and make no use of the teeth on the other side; and in a few years, the teeth which he does not use, will become exceedingly tender and begin to decay, and he will probably lose the whole of them, while the teeth on the other side remain sound:—and let any one who has very tender teeth, accustom himself by degrees to eat crusts of bread, pilot-bread, &c., and he will soon find himself able to eat those hard substances with great ease and pleasure, and the health of his teeth will become exceedingly improved. And as a general rule, it will always be found true that, in families where there are several children of the same parents, and where some of those children prefer the crusts of the bread set before them, and others the soft part, the former will have much sounder and better teeth than the latter, and will preserve them free from decay much longer in life.

§ 724. Physiologists and dentists have differed much in regard to the nature and causes of the diseases of the teeth; yet there does not appear to be any real grounds for a difference of opinion on the subject.—The teeth are organic portions of the animal body. The enamel is a species of organic crystalization, (§ 327.) destitute of nerves and vessels, and therefore wholly incapable of both healthy and morbid sensibility; and yet, in the living head, its sound condition is very closely connected with the healthy condition of the bony substance which it surrounds. (§ 423.) The bony portion of the teeth is supplied with both vessels and nerves, and is at least capable of a high degree of morbid sensibility; and the very fact that the disease of the teeth is attended with pain, is a full and conclusive demonstration that the disease is purely organic, and as such, always originates in the bony portion of the teeth, by a species of inflammation.

In very many instances, it is true, the disease commences on the outer surface of the bone, contiguous to the enamel, and perhaps most frequently in such instances, the disease is caused by the fracture or destruction or injury of the enamel. But, strictly speaking, the enamel itself is incapable of disease. It is injured or destroyed by chemical and by mechanical causes, and is broken off in fragments, or slowly disintegrated; but this cannot properly be called disease. Whether caused by the injuries or destruction of the enamel from without, or by disorders from within, then, the *disease* of the teeth has its seat wholly in the bony substance and is purely organic.—Among the external causes acting directly on the teeth, heat is certainly the most powerful. It is common to hear people speak of sugar, calomel, and other substances as very injurious to the teeth, from their external action: but if these substances were only permitted to come in contact with the external surface of the teeth, and were never swallowed into the stomach, the teeth would suffer very little from them.—The most extensive and pernicious causes of disease to the teeth, are those which act on them through the general organic economy of the system. Whatever produces a general disturbance of function, and causes a general morbid irritability of the nervous system, assails the teeth in common with all the other organs; but they will react against such causes with more or less vigor, according as the performance of their function and other circumstances are more or less favorable to their health.—If the food is soft and hot, or concentrated or high-seasoned, or otherwise vicious, and mastication is neglected, incrustations of tartar will gather around the neck of the teeth, and irritate the gums, and separate them from the enamel, and irritate the membrane which surrounds the roots; (§ 323.) and

this irritation will soon be extended to the membrane which lines the inner cavity of the roots and body of the teeth, (§ 327.) the teeth will become very tender, and soon begin to be inflamed and painful; and decay will follow, and the teeth must be lost, unless the progress of the disease is arrested by correct habits, aided by the art of the skilful dentist; which should never be neglected.

§ 725. The teeth therefore, do not suffer alone by the violation of their laws of constitution and relation. The gums and salivary glands, as well as the mucous membrane of the mouth, the organ of taste and the alimentary canal, are necessarily involved in the injury, and react upon the teeth and upon each other. The gums become tender and irritable, separate from the neck of the teeth, and often become flaccid and exceedingly ulcerous.—All this hastens the destruction of the teeth.

§ 726. The importance of the proper quantity and quality of saliva, in order to the healthy condition and functions of the organs of the mouth and the stomach, has been greatly overlooked. We have seen (§ 426.) that, when the food is properly and thoroughly masticated and freely mixed with saliva, it is not only completely comminuted in the mouth, but it also undergoes something of a change, approaching towards the character of chyme: and hence the more completely and perfectly the functions of the mouth are performed, the more perfectly is the food fitted for the function of the stomach.—Not only the quantity but the quality of the saliva may be exceedingly varied by the different conditions of the salivary glands; and these conditions depend very much on the kind and degree of stimulation which induces their secretion: and hence different kinds and conditions of substances received into the mouth, affect those glands

differently, and cause correspondent variations in the character of the saliva.—The imperfect mastication and insalivation of the food, becomes a source of irritation to the stomach; and all irritations of the stomach, from whatever cause, react upon the salivary glands, greatly affecting their condition and the character of their secretion; and thus an unhealthy quality of saliva and other oral secretions is produced, from which the calcareous incrustation which gathers around the teeth is formed, and thereby the gums and teeth are irritated and diseased. In this manner the saliva is sometimes rendered so vicious that it becomes exceedingly acrid,—scalding and blistering the parts over which it flows, and greatly disturbing the function of the stomach.

§ 727. When therefore, the laws of constitution and relation, in regard to the teeth, are precisely fulfilled, in kind, quality and condition of the food, and when the teeth most perfectly perform their function, the laws of relation in regard to the gums and salivary glands are obeyed, and the best quality and quantity of saliva is secreted for the use of the system;—and when the laws of constitution and relation in regard to the organs of the mouth are fulfilled, then is the masticated food precisely of the nature and condition best adapted to the constitution and functional powers of the stomach;—for there are, as I have stated, (§ 716.) the most fixed and precise constitutional laws of relation between the teeth and the alimentary canal:—so that precisely that kind, quality and condition of food which is best adapted to the constitutional nature and relations of the teeth, is also best adapted to the constitution and functional powers of the alimentary canal :—and precisely that degree of mastication of the food which the highest welfare of the teeth requires, is indispensably necessary to the best condition

and functional conduct of the stomach and bowels.—If the food is imperfectly masticated and too rapidly swallowed into the stomach, it becomes a serious cause of irritation to this organ, and always tends to produce functional derangement not only of the stomach itself, but, by the sympathetic influences of the stomach, of all the other organs of the system: (§ 297.)—and when by such, or other means, the functional vigor and integrity of the stomach becomes impaired, the imperfectly masticated food—after remaining in the gastric cavity for some hours, a cause of irritation and disturbance, is frequently rejected by eructations, or permitted to pass in a crude state into the intestinal tube, where it becomes a cause of serious and sometimes fatal disturbance, producing flatulence, colic, spasms, convulsions and even death. (§ 436.)—It is therefore, of the utmost importance, not only to the teeth, but to the whole apparatus of alimentary organs, and to the whole vital economy, that the food should be fully masticated, and slowly swallowed into the stomach: and in order to do this, it is of the utmost importance that, as a general fact, the food should be of a kind, quality and condition requiring and compelling thorough mastication and slow deglutition.

§ 728. Every thing unfriendly to the sound constitution and permanent health of the teeth, is far more efficacious in its pernicious effects on those organs in childhood, than in later periods of life. (§ 327.) Indeed, there is no other period in which the teeth are so deeply and permanently injured as they are previous to their appearance above the gums. It will be remembered that, during the development of the temporary or infant teeth, (§ 323. 324.) the germs of the permanent teeth are formed, and deposited in appropriate cells in the spongy substance of the jaw-bone, (§ 325.) where they remain

till the general wants of the organic economy require that the permanent teeth should take the place of the temporary ones. During this whole period of six or seven years or more, these germs participate in all the general affections of the system; and always more or less partake of the morbid irritations and irritability of the nerves of organic life. (§ 225.) From the time these germs begin to be developed till the teeth are completely formed, or during the process of second dentition, every disturbing cause in the organic domain, strikes at the very constitution of the teeth and does them an irreparable injury, preparing them for early disease and decay.

§ 729. Calomel and other kinds of mineral medicine, and in fact all medicine which has a general effect on the system, is peculiarly injurious and often destructive to the permanent teeth, when taken before those organs are completely formed. Every thing in the dietetic and other habits also, during this period, which is exciting and stimulating to the system, producing feverishness or intensity of action, and which is calculated to hasten on the process of second dentition, necessarily has an unhealthy effect on the organic constitution of the teeth, and renders them more susceptible to the action of those causes by which they are diseased and destroyed. And even after the permanent teeth are completely developed, their vessels and nerves being considerably larger and pervading the bony substance more extensively and abundantly in youth than in later life, (§ 327.) they are much more liable to deep organic injury and painful and destructive disease from the internal action of disturbing causes, than they are in later periods. And hence, it is of the utmost importance to the permanent welfare of the teeth as well as of the whole system, that the diet of children should be plain, simple and unexciting; and

that every proper measure should be taken to preserve the general health of the system.

Constitutional Relations of the Skin and Lungs.

§ 730. The primary organs of external relation, I have said, (§ 698.) are the alimentary canal, the lungs and the skin. In some animals the skin is supposed to be a principal organ of respiration; and it has also been supposed to be, to some extent, an organ of alimentation. In man, its powers of absorption, as an organ of alimentation, are exceedingly small, if indeed, it can justly be said to possess any. (§ 331.) As an organ of respiration, the human skin is of much more importance. In a healthy and vigorous state, and when not too much confined by clothing, its action on the atmosphere is very similar to that of the lungs, (§ 516.) and hence there are the same or similar constitutional and functional laws of relation between the skin and the surrounding atmosphere, that there are between the lungs and atmosphere: and these I shall explain when I come to speak of the lungs. As an extended organ of touch, the skin has constitutional relations to external things, the general principles of which have already been sufficiently explained in speaking of the other organs of sense. (§ 253.)

§ 731. The lungs are constituted with fixed and precise laws of relation to the external air. Pure air, I have said, (§ 473.) when at the very point of truth in its constitutional nature, consists of twenty parts in a hundred, by measure or volume, of pure oxygen gas, and eighty parts of nitrogen or azote. These are not chemically combined, (§ 474.) as oxygen and hydrogen are in water, but they are thoroughly mixed together, in the proportion of one fifth part of oxygen with four fifths of azote; and

they are held together, if the views of modern chemists are correct, by affinities peculiar to the atmospheric constitution; for although a given volume of oxygen is heavier than the same volume of azote, and therefore, reasoning *a priori*, we should conclude that oxygen would be much more abundant in the lower regions of the atmosphere, and that azote would be much more abundant in the higher regions; but the air brought from the highest point of elevation to which any human being has yet ascended, is found, on analysis, to consist of precisely the same qualities and proportions that the air does which is taken from the lowest valley. The only explanation which the present state of science can afford for this interesting fact, is that, oxygen, which in its pure state is a little heavier than the common atmosphere, and azote, which in its pure state is a little lighter or less dense than the common atmosphere, are thoroughly mixed together in the proportions I have named, and constitute pure atmospheric air, not only in the lowest valleys, but on the tops of the highest mountains, and at all known altitudes; and these substances are held together in those proportions, by laws of constitution peculiar to the atmospheric air. So that, if a large quantity of oxygen and azote were set free, they would at once mix together, according to the constitutional laws of atmospheric air, in the proportion of one volume of oxygen with four of azote, and if there was an excess of oxygen it would sink towards the earth and remain in its free state until it found something to combine with; and on the other hand, if there was an excess of azote it would ascend up. This then, is the constitutional nature which God has given to the atmospheric air; and he has given to each and every individual vegetable and animal in the whole organic world a constitutional nature holding a fixed and precise

relation to the constitutional nature of pure air. The small quantity of carbonic acid gas and the vapor which are always found in the atmosphere, (§ 473.) need not now to be taken into account.

§ 732. The human body, like other animal bodies, derives what may properly be called a portion of its nourishment, from the atmosphere; (§ 480.) and this nourishment is not only essential to our existence, but we cannot live many minutes without a supply of it.—As a general statement, the oxygen alone is the nutritious principle of the air which we breathe, (§ 482.) and the azote is wholly innutritious.—Pure air then, contains only one part of nourishment for our bodies, mixed with four parts of innutritious substance; and the lungs are obliged to receive this air with its large proportion of innutritious substance, for the sake of receiving its small proportion of nutritious substance, which they separate out and appropriate to the nourishment of the system by a vital process which may be called pulmonary digestion. (§ 481.)

§ 733. Now it may be asked, Why would it not be an excellent plan to establish all over the face of the earth, a vast multitude of large chemical laboratories, for the purpose of analyzing the atmosphere, and procuring as much pure oxygen gas as mankind would require for their nourishment; and thus save the human lungs from the very laborious and wearing task of separating the nutritious principle of the atmosphere from such a large quantity of innutritious matter, and especially in all cases of weak and delicate lungs.—Considering the rage of mankind for concentrated and stimulating substances, it is indeed a marvel, that an enterprise of this kind has not been undertaken: and no doubt it would have been long since, if men could have *felt* their way

into such a mode of pulmonary stimulation.—But such an artificial preparation of air for the human lungs, would be ruinous to the lungs and destructive to the whole body: because God has organized man and established the laws of vital power and action within him, with the most fixed and precise relations to the constitutional nature of atmospheric air as it is in a natural and pure state.—He has formed the lungs to receive and digest air that is composed of four parts of innutritious matter and one of nutritious, and therefore every deviation either way from this point of constitutional truth, in the character of the air, must necessarily be injurious to the lungs, and through them to the whole system.—If we were to breathe pure oxygen gas or air, there would be a greatly increased action in the whole system and all the vital phenomena would be exceedingly enhanced; the lungs and other organs would become inflamed, and the vital powers would soon be completely exhausted and the vital constitution destroyed. On the other hand, if we were to breathe pure azote we should instantly suffocate, because it is wholly innutritious of itself, and therefore cannot alone, support respiration. (§ 475.) Just in proportion as the air we breathe, deviates from the constitutional truth of pure atmospheric air to an excess of oxygen, the vital action and exhaustion of our system are increased,—the functional power of the lungs is diminished,—the general principles of disease are developed, and life is abbreviated. And just in proportion as the air we breathe deviates in the other direction to an excess of azote, the function of respiration becomes depressed, laborious and imperfect,—the blood and all the other substances of the body, suffer a commensurate deterioration, (§ 484.)—all the functions in the system languish,—the lungs and other organs lose their most

healthy tone and elasticity, and the whole system tends to disease and decay.—When these deviations in either direction, are exceedingly small at first, and gradually increased, we may not be sensible from immediate and distinctly marked manifestations, that the air which we breathe is not best adapted to our lungs;—nay indeed, we may so far deprave our lungs that they will prefer the presence of air which is loaded with the poisonous odor of tobacco, to the presence of pure air. (§ 287. 290. 296. 706.) Nevertheless it is most strictly true, that all deviations, to an excess either of oxygen or of azote, in the air we breathe, are commensurately injurious to the lungs, and to the whole system. We are therefore, so organized in relation to the constitutional nature of pure air, that the innutritious property of the air is, in its true constitutional proportion, just as important to the permanent welfare of our lungs and our whole system, as the nutritious property is.—I have entered thus fully into the explanation of the constitutional laws of relation between the lungs and the atmospheric air, mainly because there is, in this respect, the most perfect analogy between the lungs and the alimentary canal.

Constitutional Relations of the Alimentary Canal.

§ 734. The human stomach with the intestinal tube, I have said, (§ 697.) is constituted with the most fixed and precise relations, not only to the blood and all the other substances of the body, and all the other organs of the system, but also to those foreign or external substances designed by our Creator for our aliment. (§ 698.) The direct and important relations between the stomach and the teeth, we have already contemplated, (§ 725.) and seen that, precisely that kind, quality and condition of

food, which are best for the teeth, are best for the stomach, after having been subjected to the function of the teeth; and that, the more perfectly the function of the teeth is performed, the better the masticated food is prepared for the function of the stomach. (§ 727.) The stomach, it will be remembered, besides the mucous membrane which lines it on the inside (§ 338.) and the peritoneal coat which envelops it on the outside, (§ 350.) has a muscular coat, (§ 347.) of which one set of fibres run lengthwise of the organ, and another set run around it, at right angles with the first, or nearly so; and a third set of oblique or spiral fibres, continuing from the œsophagus and being distributed mostly to the large end of the organ. Simply as a digestive organ, the stomach, it will be remembered, is supplied from the domain of organic life (§ 231.) with three sets of nerves. (§ 230.)—First, those which belong to its blood-vessels concerned in nourishing its tissues, and those which belong to its secreting and absorbing vessels. Second, the nerves which convey the stimulus of motion from the centre of perception and action to the muscular tissue of the organ; and third, the nerves of organic sensibility by which the stomach is sensible of the presence and properties of the substance received into it. (§ 429.)

§ 735. Our infinitely wise and good Creator, I affirm, has organized man to subsist on certain substances, which He had previously created with fixed constitutional natures and properties; and therefore, there is a perfect constitutional adaptation of our organs to those substances and of those substances to our organs. (§ 698.) And as God created man to be the lord of the earth, and to occupy all portions of it, he constituted him with a wide range of adaptability, to meet the exigencies of the circumstances and conditions in which he might be

placed:—but always of necessity, under this great and immutable law—that IN PROPORTION AS MAN TURNS ASIDE FROM THE TRUTH OF HIS NATURAL AND PERFECT CONSTITUTIONAL ADAPTATION, AND EDUCATES HIMSELF, BY VIRTUE OF HIS CONSTITUTIONAL ADAPTABILITY, TO HABITS, CIRCUMSTANCES AND CONDITIONS LESS ADAPTED TO THE TRUTH OF HIS CONSTITUTIONAL NATURE, HE IMPAIRS ALL THE POWERS OF THAT NATURE AND ABBREVIATES HIS EXISTENCE.

§ 736. In its constitutional nature, every substance has properties adapted to the end or ends for which it was created; and this is strictly true of all substances designed for human aliment; (§ 700.) and therefore, the human organs have capacities and powers perfectly adapted to these properties. (§ 294.—296. Hence we have organs with the special sense of sight, adapted to the visual properties of things,—organs with the special sense of hearing, adapted to the auditory properties of things,—an organ with the special sense of smell, adapted to the olfactory properties of things, or to odors,—an organ with the special sense of taste, adapted to the gustatory property of things, (§ 566.) and the sense of touch, adapted to the tangible properties of things: (§ 242.) and each of these properties, is the natural and appropriate stimulus of the special sense adapted to it. These organs which I have now enumerated, all pertain to *animal* life, and are endowed with *animal* sensibilities; (§ 292.) but the organs belonging to the domain of organic life, are endowed with organic sensibilities, equally determinate and equally specific, in relation to the properties of things, designed to be their natural and appropriate stimuli. (§ 296.)—And hence, the nerves of organic sensibility belonging to the human stomach,

(§ 734.) in a perfectly normal and undepraved state, are endowed with a special organic sense, by which they, with the most perfect accuracy and exquisite delicacy, perceive and appreciate the specific alimentary stimulus of every substance received into the gastric cavity, and instantly convey the impression which they receive, to the centre of perception and action (§ 220.) which presides over the function of the stomach, and which immediately calls up those powers, requisite for the performance of the function of that organ, according to the character of the stimulus perceived. (§ 429.)

§ 737. While the stomach is preserved in a perfectly healthy and undepraved state, its organic sensibility enables it to detect and appreciate with the utmost accuracy, both the *quality of the stimulus* and the *degree of stimulation*; and consequently enables it to discriminate, with the same accuracy, between those substances which are best adapted to the vital interests of the system, and those which are pernicious or offensive, or even less adapted to the vital wants.—When the quality and quantity of the substance received into the stomach, are best adapted to the vital interests of the system, the stimulation of this organ is sympathetically diffused over the whole system (§ 297.)—and the whole organic domain, within us, rejoices under its healthful influence; and we have an animal and intellectual and moral consciousness, not of a local organic stimulation, but of a general buoyancy of spirits—and intellectual sprightliness and moral enjoyment; (§ 305.)—and when any pernicious, or offensive substance is introduced into the stomach, this organ in its integrity instantly detects its character, and if necessary for the security of the vital interests, promptly gives the alarm to the whole organic domain, and when requisite,

causes a manifestation of strong symptoms, in the domain of animal life. (§ 300.)

§ 738. But this special organic sense of the stomach, like the special animal sense of taste and smell, (§ 704. 707.) may be exceedingly depraved, and even totally destroyed; so that the stomach may become not only wholly destitute of the power to perceive and appreciate the *quality* of the stimulus which acts upon it, and to discriminate between those substances which are salutary and those which are pernicious to the system, and thus be reduced to the mere ability to appreciate the *degree* of its stimulation,—but it may even be made to prefer those substances which are decidedly pernicious to the vital interests; because, in its depravity, it is so adapted to the stimulating properties of those substances, that it receives from them the most satisfactory *degree* of stimulation.

§ 739. But the stomach, as we have seen, (§ 298.) is too important an organ in the vital economy, and too directly and powerfully related to all the other organs of the system, to sink to this state of depravity alone. (§ 521.) By direct sympathetic irritations and by the deterioration of functional results, the whole system is made to partake of the depravity of the stomach; and in this state of things, substances of the most pernicious character, may be habitually thrown into the gastric cavity, and either rapidly or slowly destroy the constitutional powers of the system, and work out disease and death. (§ 458.) And because the stomach has no longer any power to detect and appreciate the true character of those substances, and therefore has neither the disposition nor the power to give any alarm of danger to the organic domain, but remains quiet and even satisfied with their presence, while they are perpetrating their deeds of death,—we, as ani-

imals and as intellectual and moral beings, remain wholly unconscious of this state of things, and earnestly contend for the safety of our habits and conditions, on the ground that our stomachs are satisfied with them, and therefore, our experience proves them to be good.—Moreover, in this general condition of the system, the stomach not only loses the power to discriminate between good and evil, and to give the proper alarm when the vital interests are in jeopardy, but it also, to a very great extent, loses the power of manifesting true and proper symptoms when it is itself actually diseased. And it is a most fearful fact, as we have seen, (§ 520.) that extensive disease may exist in the alimentary canal, and gradually increase for a long time, and even terminate in death, without being manifested by any of those symptoms, which lead either the subject, or the physician to suspect it.—I have found in post mortem examinations, astonishingly extensive disease pervading the whole stomach and intestines, of a character which indicated a progress of many years; and yet the subject was not during life in the least sensible of its existence.

§ 740. This deeply interesting fact has been considered as wholly inexplicable, upon any known physiological or pathological principles:—and it is very certain that those principles which I have just stated, are the only ones which can afford a satisfactory and correct explanation of the phenomena in the case. While the system is in a pure state, and the organs are undepraved, the alimentary canal will always promptly detect the presence of any morbid or disturbing cause, and with perfect integrity, exhibit the most distinct and unequivocal symptoms of morbid conditions and affections, or functional derangements. But when the natural sensibilities and sympathies of the system, have been depraved and crip-

pled by habitual violations of the laws of constitution and relation, the alimentary canal is robbed of its power to appreciate discriminately the character of such causes, and to awaken such sympathetic manifestations as distinctly indicate its disturbances and its diseases:—and therefore, like an individual who has been deprived of his eyes and tongue, it necessarily submits to the gradual and continual encroachments of depraving and diseasing causes, without the power to perceive or to tell what harms it, till the accumulation of wrongs becomes too great for vital endurance, and the general indignation of the system is roused into an acute disease, which either throws off the oppression, or the vital powers sink under the conflict, and death ensues:—or else, the alimentary canal, or some other part more debilitated or morbidly predisposed, becomes the seat of slowly progressing local disease. When the lungs, liver or any other organ whose natural sensibilities are less depraved than those of the alimentary canal, becomes the seat of local, chronic disease, the symptoms of such disease are always less obscure and equivocal;—but when the stomach and intestinal canal become the seat of chronic disease, not induced by any one violent cause, but by the constant and long-continued irritations, almost universal in civic life, and indeed, throughout the human world, the depraved and crippled organ has no power to announce its difficulties, in distinct and unequivocal symptoms.

§ 741. It is true that symptoms of disease somewhere within the vital domain, might be detected by an accurate observer;—but these are often so purely sympathetic and so remote from the real seat of the disease, and so ambiguous in their character, that it is impossible to derive any correct and definite information from them. It is true also, that when long-continued abuses accumulate

oppression upon the system, till the diseased organ can no longer bear it quietly, morbid sympathies are aroused, and all the instinctive energies of organic life are sometimes thrown into a blind and terrible agony to remove the oppression; and in some cases, the powers of animal life are, to a considerable extent, or even totally involved:—so that spasms, cramps, convulsions, delirium and even an entire suspension of animal life result. But these symptoms, though dreadfully violent, do not by any means distinctly indicate local disease; and still less do they point out the seat of such disease.—Thus by violating the constitutional laws of relation in regard to the alimentary canal, we not only destroy its integrity in health, but also take away its power to make known its morbid conditions, and thereby the vital interests of our bodies are doubly endangered.

§ 742. It is exceedingly unfortunate for mankind, that very few are capable of discriminating between the natural and healthy sensibilities of an undepraved stomach, and the morbid irritability of a depraved stomach; although the distinction, to a properly enlightened mind, is very broad and manifest.—The morbid irritability of a depraved stomach, renders it exceedingly capricious and peevish, and causes it to reject or receive things without any regard to the true interests of the vital economy:—the natural and healthy sensibilities of an undepraved stomach, on the other hand, cause it always, at proper times, to receive in proper quantities and conditions, with great satisfaction, those substances which are adapted to the real and true wants of the vital economy, and promptly to reject, or strongly to complain of those substances which are unfriendly to the vital interests. Yet most men exceedingly deprecate the integrity of a healthy and undepraved stomach, because

it faithfully tells them when they violate its constitutional laws of relation, and causes them that distress as a penalty of their transgression, which God in benevolence designed to restrain them from those trespasses which are destructive to health and life. They call such a stomach weak and out of order, and greatly prefer one that will receive all manner of unclean things without any resistance or complaint: and consequently they condemn as exceedingly pernicious, those habits of life, which restore the depraved stomach to its natural and healthy sensibilities.—They are given up to strong delusion, that they may believe a lie, and that they may perish, because they receive not the love of the truth, but prefer the pleasure of unrighteously gratifying their sensual appetites.

§ 743. In relation to the digestive organs of the human body, every foreign substance, designed for human aliment, or from which the body can derive nourishment, possesses, in its constitutional nature, a stimulating quality specifically proportionate in power, to its quantity of nourishment. Some substances are much more nourishing and less stimulating than others; some are much more stimulating and less nourishing; and there are also some substances in nature which are purely stimulating, without affording any nourishment. These last, of course, are never to be used as articles of food, but used only, if at all, as remedial agents, in particular conditions of the system.

§ 744. By the stimulating properties of those substances which are designed for our daily food, our digestive organs, in a healthy and undepraved state, are excited to the performance of their functions; and in being thus excited, they always necessarily suffer an exhaustion of vital power and a waste of substance (§ 376.) commen-

surate with the degree and duration of the excitement. But the replenishing and nourishing economy of the system is continually carried on, to counteract these effects and sustain the organs in the regular performance of their functions. (§ 393.) Yet if the excitement is very intense, the exhaustion is too rapid for the replenishing economy and the organ is proportionably debilitated and prostrated,—and a deeper and more painful sense of exhaustion is felt. (§ 518.)

§ 745. Now then, it is very certain, and very obvious that, those proper alimentary substances whose stimulating power is barely sufficient to excite a full and healthy performance of the functions of the digestive organs, in the appropriation of their nourishment to the system, are most conducive to the vital welfare of the body in all respects,—causing all the vital processes of assimilation and organization to be most perfectly performed, without any unnecessary expenditure of vital power, and thus contributing in the highest degree to the most permanent and uniform health and the greatest longevity:—for every degree of stimulating power beyond this, necessarily increases the vital exhaustion, without contributing in any measure to the welfare of the body.—For illustration, suppose we have one article of food which contains fifty per cent. of perfectly healthy nourishment with fifty per cent. of stimulating power, and another article of food containing thirty-seven and a half per cent. of perfectly healthy nourishment, with sixty-two and a half per cent. of stimulating power:—and suppose that the first article contains stimulating power sufficient to excite the digestive organs to a full and healthy performance of their functions in appropriating its nourishment to the wants of the system: then by taking the second article, we should receive in proportion to the quantity of nourishment, twenty-five per cent. more of

stimulating power:—and the results would be these—The organs would be proportionably more exhausted,—the vital processes of assimilation and organization would be more rapidly and less perfectly performed (§ 644.)—health would be less uniform and secure and life would be shortened. And all these effects are produced to a yet more injurious extent, by the habitual use of the pure stimulants with the nutritious articles of food, because in a healthy state of the organs, they are entirely unnecessary, and only serve to increase the exhaustion of the organs and to deteriorate the functional results; and if by any means, the organs have been reduced to a state in which they seem to require something more than the natural stimulus of the food, to excite them to the performance of their functions, then are they really so much the less able to bear the action of the pure stimulants, and so much the less qualified to perform their functions with integrity,—and the consequence is not only exhaustion, but irritation and debility and the development of disease. (§ 518.)

§ 746. It is therefore, one of the most important laws of the vital economy that, that aliment which is most perfectly assimilated and incorporated by the vital functions, with the least expense of vital power, is best adapted to the wants of the system; and most conducive to health and long life, (§ 644.) and to the highest and best condition of human nature in all respects.

§ 747. Like the atmospheric air, (§ 731.) all those substances in nature, designed for human aliment, are composed of certain proportions of nutritious and innutritious matter, and the alimentary canal like the lungs, (§ 732.) is constituted with determinate relations to the constitutional nature of alimentary substances in this respect. I do not say that the stomach like the lungs, is

constituted, to receive natural substances containing precisely one volume of nutritious, with four volumes of innutritious matter:—but that the stomach and intestines are, like the lungs, really and truly constituted to receive substances composed of both nutritious and innutritious matter, (§ 438.) and that, there is somewhere a point of truth in the proportions, best adapted to the constitution and functional powers of the alimentary canal, and the vital welfare of the whole system; and that, so far as we vary from this point of truth, by increasing or diminishing the proportion of the nutritious to the innutritious matter of our food, we do, as a general fact, injure the alimentary canal, and, through it, the whole body. And it is very certain that too great a proportion of nutritious matter in our food, is little less dangerous to our digestive organs and to the vital interests generally, than too small a proportion.—If the human stomach had been designed to receive only nutritious matter, the intestinal tube would be an unnecessary appendage to it. But every thing in the anatomical structure and physiological powers of the alimentary canal, clearly and fully demonstrates that, it is constituted with wise and determinate relations to natural alimentary substances composed of nutritious and innutritious matter: and all experience corroborates this demonstration.—It is the duty of the alimentary canal to receive these substances, at proper times and in proper quantities, after they have been thoroughly masticated and insalivated in the mouth, and completely to dissolve them or separate their nutritious from their innutritious matter, and convert the nutritious matter into chyme (§ 438.) and present this to the absorbing mouths of the lacteals, and then to remove the fecal or innutritious residuum from the organic domain. (§ 456.)

§ 748. If therefore, instead of supplying the alimentary

organs with food composed of due proportions of nutritious and innutritious matter, we artificially separate the nutritious from the innutritious, (§ 733.) and supply the alimentary organs only with the concentrated nutritious matter, we shall soon destroy the functional powers of the organs,—break down the general function of nutrition, and cause atrophy and death. Many experiments have been made by Magendie and other distinguished physiologists to demonstrate the truth of this doctrine; and notwithstanding there has been abundance of inaccuracy, both in the mode of the experiments and in the reasonings founded on them, yet the general results fully corroborate the *a priori*, physiological reasoning which I have just presented. Magendie found that dogs fed on sugar and distilled water, began to droop in a few days, and gradually to become more and more emaciated and weak, and finally became diseased with ulcers, and died in about a month. Similar experiments were made with olive oil, gum Arabic, butter, superfine flour bread and some other articles, each given separately and exclusively, with water, to different dogs; and the results were nearly identical in all the cases;—the dogs soon began to droop, their appetite became impaired, and they became extremely emaciated, and died in little more than a month.—Led away by the ruling propensity, so common among modern physiologists, to account for all the phenomena of the vital domain upon chemical principles, (§151.) Magendie, conjectured that these effects were caused by the want of azote in the substances on which the dogs were fed:—but we have seen, (§ 465.) that such conjectures are not sustained by any correct principles in physiological science. It is not in the power of chemistry in the least possible degree, to ascertain what substances the alimentary organs of the living animal body require for the

nourishment of the body, nor from what chemical elements the organic elements are formed; nor with what laws of arrangement they are constituted. (§ 122.) Other physiologists, by similar experiments and results, have been led to the conclusion, that *VARIETY of aliment* is essential to animal existence and health. This, however, though it may be true of some particular animals, cannot be asserted as a general law.

§ 749. But it is a general law, established in the constitutional nature of things, and extending, at least, to all the vertebrated animals, that alimentary substances composed of both nutritious and innutritious matter, are necessary to sustain the functional powers of the alimentary organs; and therefore, essential to animal life and health.—Some species of animals require a greater proportion of innutritious matter in their food than others; but all require some.—This great physiological law solves all the phenomena of Magendie's experiments, without the help of chemical science: and all correct experiments of the kind fully confirm its truth.—Thus, if dogs be fed on sugar and water, they will die, in the manner I have stated: but if a considerable proportion of saw-dust be mixed with the sugar, they will not die, but they will thrive and do well although they are naturally carnivorous animals.—If dogs be fed on superfine wheat-flour bread and water, they will die in about seven weeks; but if they be fed on bread made of the whole natural substance of the wheat, or on unbolted wheat-meal bread and water, they will live and do well.—An ass fed on rice will die in about fifteen days; but if a large quantity of cut straw be mixed with the rice he will thrive on it.—Horses fed exclusively on meal or grain will die in a short time; but mix their meal or grain with a suitable proportion of cut straw or wood shavings, and

they will thrive and become fat.—And it is an interesting fact, that if horses be fed on grain alone, with water, for a number of days, they will instinctively gnaw the boards, or whatever woody substance is within their reach.

The following interesting statements are of the most unquestionable authority, and may be relied on with the utmost confidence.

§ 750. About forty years since, Captain Josiah Hussey sailed from Boston with a deck load of horses, for the West Indies. They had been out but a few days, when a severe gale came on, and carried away all their hay and drove them a considerable distance out of their course. There was a plenty of grain below the hatches, and Captain Hussey was obliged to feed his horses entirely on grain.—For a few days the horses seemed to do tolerably well:—and then they began to droop, and lose their appetite and languish, and finally they began to die one after another, rapidly: and Captain Hussey was apprehensive that he should lose all he had on board before he got into port. In this emergency, seeing the horses eagerly gnawing the scantling and spars within their reach, he ordered his hands to take a drawing knife and shave up a quantity of stave timber which he had on board, and give the shavings to the horses, with their grain. The horses devoured these shavings with greediness, and soon began to recover their health and spirits, and no more of them died, but they all continued to improve till they got into port.

§ 751. “About thirty years ago,” says Governor William King, of Maine, “I went to the West Indies, and during my voyage became acquainted with the following fact, which may be relied on as strictly true. A vessel from New England with a deck load of horses, bound to the West Indies, was overtaken by a violent gale which swept

away all the hay on board, and carried away the masts.—The captain was obliged to feed his horses on corn.—After a while they began to droop and to lose their appetite, and at length, wholly refused to eat their grain, and began to gnaw the scantling and spars within their reach and to bite at the men and every thing else that came in their way. The captain threw pieces of wood before them, which they immediately began to eat. After this, he regularly supplied them with a quantity of cedar shingles, which they eagerly ate as they would hay, and soon recovered their appetite for their grain, and improved in health and sprightliness and continued to do well on their food of corn and cedar shingles till they got into port.”

§ 752. “About the first of December, 1800,” says Captain John Mathews, of Maine, “I left Bath, in the schooner Betsey, with a deck load of cows, oxen, horses and one mule. Expecting to have a short passage, I took but little hay:—when we had been out several days, a gale came on which swept away most of our hay and drove us so far out of our course, that we were fourteen days without hay before we made the island of Bermuda.—We had a plenty of corn and potatoes on board, with which we fed our stock.—After three or four days, the stock all began to be indisposed and to droop and to be unwilling to eat the food we gave them, and they seemed to be very uneasy and to crave something which they had not: and the mule began to gnaw a spruce spar which lay before him. This suggested to me the thought that my stock all required more woody matter with their food, and I immediately caused some spruce and oak spars to be shaved up with a drawing knife, and gave the shavings to the stock. All the young cattle and horses and the mule ate these shavings greedily, and were

very soon improved in their health, and continued to do well the remaining part of the voyage.—The mule ate them more freely than any other animal on board, and he improved most. Indeed, he was quite plump and sleek when we arrived in port.—Some of the older cattle and horses would not eat the shavings, and every one of these died before we got in.—About the year 1830," continues Captain Mathews, "returning from Bonavista, one of the Cape de Verd Islands, I brought several goats with me. Having no hay on board, I fed them with grain and shavings. They came every day as regularly for their shavings as they did for their grain, and ate them as greedily."

§ 753. "Some years since," says William Richardson, Esq., of Bath, Maine, "I spent a number of weeks on the island of Bermuda, in the West Indies. The family with which I boarded had a cow which they kept almost entirely on grain. I used to go nearly every day regularly into a ship yard that was near the house, and sit there by the hour; and I invariably observed that the cow would come every day, and eat freely and even greedily of the shavings and chips in the yard. At the time, I could not well account for this, but supposed she ate them to satisfy hunger, but I am now convinced that she instinctively took this method of supplying herself with a due proportion of innutritious substance,—the grain on which she was fed being a too concentrated form of food for her organs."—Innumerable facts of this kind, might be collected, both in regard to herbivorous and carnivorous animals;—and the whole history of the human species, in civilized life at least, is replete with demonstrations of the same great physiological principle.

§ 754. Children whose food for a considerable time, consists of superfine flour bread and other concentrated

substances, such as sugar, butter, &c. generally become weak and sickly and are often covered with sores: and perhaps become afflicted with scrofulous diseases: and hence some physicians who have written on the diet of children, have spoken in severe terms against confining children to an exclusively vegetable diet: but if a child be put upon a diet of good bread made of unbolted wheat meal, with milk and water or pure soft water for drink, and be allowed to indulge pretty freely in the use of good fruits in their season, none of the evils which result from concentrated forms of aliment, or which are attributed to vegetable diet, will be experienced, but the child, if in other respects properly treated, (§ 1265.) will be healthy and robust and sprightly.

§ 755. I have been informed by old whalemén, that they had long observed, and that it is a common remark among them, that during their long voyages, the coarser their bread the better their health.—“I have followed the seas for thirty-five years,” said a very intelligent sea-captain to me a few years since, “and have been in almost every part of the globe, and I have always found that the coarsest pilot bread, which contained a considerable proportion of bran, is decidedly the healthiest for my men.”—“I am convinced from my own experience” says another gentleman of the same calling, “that bread made of the unbolted wheat meal, is far more wholesome than that made of the best superfine flour,—the latter always tending to produce costiveness.” Captain Benjamin Dexter, in the Ship *Isis*, belonging to Providence, R. I., arrived from China in Dec. 1804. He had been about one hundred and ninety days on the passage. The sea-bread which constituted the principal article of food for his hands, was made of the best of superfine flour.—He had not been long at sea before his hands began to

complain of langour, loss of appetite and debility; these difficulties continued to increase during the whole voyage, and several of the hands died on the passage of debility and inanition. The ship was obliged to come to anchor about thirty miles below Providence, and such was the debility of the hands on board, that they were not able to get the ship under way again: and the owners were under the necessity of sending men down from Providence to work her up.—When she arrived, the owners asked Captain Dexter what was the cause of the sickness of his hands. He replied, “the bread was too good.”

§ 756. The eccentric Dr. Stark, of England, is said to have destroyed his life by dietetic experiments on himself, and his case is commonly, but very erroneously adduced to prove that, too great a simplicity in diet, is not conducive to the health of the body; but that in man, a mixture and variety of food, are not only consistent with health and vigor, but indispensably necessary to both.—Never was any thing more whimsical and capricious however, than the experiments of Dr. Stark. It is said that they were undertaken at the suggestion of Sir John Pringle and Dr. Franklin. The proposed object of the experiments, was to prove that, a *pleasant* and *varied* diet is equally conducive to health, with a more strict and simple one;—yet most of the dishes which he ate during the experiments, were neither natural, pleasant nor simple; but exceedingly disagreeable compounds of concentrated substances.—He began with fine flour bread and water;—from which he proceeded to bread, water and sugar;—then to bread, water and oil of olives;—then to bread, water and milk;—afterwards he tried bread and water with roasted goose;—then bread and water with boiled beef;—then stewed lean of beef with gravy;—then oil of suet and water;—then flour, oil of suet, water and

salt;—then flour, water and salt;—then bread and fat of bacon ham;—then infusion of tea with sugar;—then bread or flour with honey and an infusion of rosemary. A number of other dishes equally disagreeable with these, and some of them even more so, were successively tried.—These experiments were commenced in July, 1769, and prosecuted with great zeal. He began them in good health and vigor; his body weighing a hundred and seventy-one pounds. His health soon began to decline, and although it varied, it was seldom if ever good afterwards. In a very short time from the commencement, the weight of his body was reduced to a hundred and sixty-four pounds eight ounces, and though some kinds of his food increased it, by much the greater part of what he used, had a contrary effect; and he continued, on the whole, to decrease, till the day of his death, which took place after the suffering of much uneasiness, Feb. 23d, 1770,—having spent nine months in the experiments.—“His friend and biographer, Dr. Smyth, who was intimately acquainted with his character and disposition, thinks that other causes, particularly chagrin and disappointment, had no small share in hastening his death.” “He was born in Manchester, Eng., July, 1740, and died Feb. 1770, aged twenty-nine years and seven months.”

§ 757. Here then, is a course of experiments, undertaken for the avowed purpose of proving that a *pleasant* and *varied* diet is equally conducive to health with a more strict and simple one: and the individual, in the violation of all correct physiological principles, changes often from one improper kind of food to another; and, in the course of nine months, runs through a very great variety of dishes,—nearly every one of which, is a compound of concentrated substances, and finally dies of disappointment and chagrin and broken down digestive powers:—and

yet this notable case is quoted almost universally by physiologists and writers on diet, and every body else that ever heard of it, to prove directly the contrary of what it was designed to prove, and of what in reality it does prove. Had Dr. Stark flourished, and enjoyed good health and lived to old age on his varied diet of compound concentrated substances, then his case might with some plausibility, have been adduced to show that man requires a varied diet, and that compound dishes of concentrated substances are favorable to human health and longevity;—but as the case is, it only goes to prove that concentrated alimentary substances, however varied, are destructive to health and life, and it might with much propriety be urged against too great a variety of food, and in favor of simplicity. Surely then, this is one of the last cases, that enlightened physiologists should cite to prove that a plain, simple, and natural diet is not best for man;—and men of scientific pretensions should be slow to advance such opinions, when the world is full of demonstrations to the contrary. I have known many individuals subsist for years on coarse, unbolted wheat-meal bread and water alone, and not only improve in health, but become remarkably vigorous and robust. And I am bold to affirm that no human being ever injured his health nor shortened his life, by a plain and simple diet, the kind and condition of which, were adapted to the physiological laws of his alimentary organs.

§ 758. Debility, sluggishness, constipation, obstructions, and morbid irritability of the alimentary canal, have been among the principal roots of both chronic and acute disease in civic life in all parts of the world and in all periods of time:—and concentrated forms of food, compound preparations, irritating stimuli, and excess in quantity, have been among the principal causes of these difficulties.

§ 759. The healthfulness and integrity of the digestive function of the stomach, we have seen, (§ 454.) depend principally on three things; 1st, healthy and vigorous nervous power; 2d, healthy secretion; and 3d, healthy and vigorous muscular action. The absence of either of these will prevent digestion.—If the nervous power is impaired, the gastric secretion is deteriorated and the muscular contractility is diminished, and the function of the organ languishes; and if the muscular contractility is impaired, the nervous power is diminished and the function languishes; and if either the nervous or the muscular tissue is destroyed, the function of the organ is entirely abolished.—The destruction of the muscular tissue of the human stomach, as effectually destroys digestion as the destruction of the nervous tissue. (§ 437.) So mutually and directly are the tissues of an organ dependent on each other, and the functional power and integrity of the organ, on the health of all its tissues.—And we have seen (§ 348.) that certain kinds and conditions of food, if long used, will almost wholly obliterate the muscular coat of the stomach; and other kinds and conditions will largely increase the development of that coat.

§ 760. The healthy excitement of the vital properties of the nervous and muscular tissues of the alimentary canal, requires the presence of ingested food which in its nature and condition is adapted to the anatomical structure and physiological powers of the stomach and intestinal tube; and therefore, if the nutritious principles of those natural substances intended for our food, be separated out by artificial means, and used in their concentrated forms, the laws of relation in regard to the teeth, gums, organ of taste, salivary glands, stomach and intestines, will be violated in such a manner, as to disorder the functions of these organs; (§ 716.) and if persevered in,

will, by slow degrees, impair their functional powers, and finally disease and destroy the organs themselves. The teeth will become diseased and painful, and will decay; (§ 519.) the gums will become soft and relaxed and tender and perhaps ulcerous.—The salivary glands will become unhealthy, and the saliva will be greatly deteriorated in quality; the nervous and muscular powers of the stomach and intestines will be much impaired; the processes of assimilation and nutrition will be less and less perfectly performed; emaciation, general debility and disease will ensue, and suffering and premature death will be the final result.

§ 761. The innutritious properties combined with the nutritious principles in those natural substances designed by our Creator for our food, are therefore, indispensably necessary, in order to excite and keep up the healthy action of those powers of the organs, which were established with direct and fixed relation to such properties in our aliment; and which are so associated with other important powers of the organs and of the system, that, on the healthy condition and action of the one, depend the healthy condition and action of the other. So that, the general health and vigor of the organ and integrity of its function, depend upon the healthy and vigorous condition and action of each and all its powers: and consequently, though the innutritious substances themselves afford no nourishment to the system, yet they keep up that general health and energy and activity of the organs, necessary for the healthy digestion, assimilation and organization of the nutritious properties, and therefore without them, or some good substitute for them, the energy and activity of the organs will inevitably become impaired, and their functions will soon become disordered, and the organs diseased and destroyed.

§ 762. It is contended by some, that, as the ultimate elements of all substances from which the human body can derive nourishment, are nearly the same, and as the chyle formed from each and all of the different substances is so nearly identical in character, that scarcely any appreciable difference can be detected by the most careful analysis, it certainly can be of little importance what substances we use for food, so that they contain sufficient nutrient matter to answer the demands of the vital economy. But this reasoning, though it may seem plausible to some, is wholly fallacious and absurd. It loses sight entirely of the grand and essential distinction between the processes of organic, vital function, and those of inorganic chemistry; and assumes that the laws which govern the vital processes, are the same as those which govern the processes of inorganic chemistry.—It is true that the ultimate elements of all vegetable and animal substances are nearly the same; and it is also true that the ultimate elements of both vegetable and animal substances are the same as the ultimate elements of all inorganic substances. But can any inorganic compound of oxygen, hydrogen, carbon and azote, be made to answer as a substitute for animal or vegetable food? Certainly not!—And the reason is evidently, not because any particular chemical character or property is wanting in such a compound, but because such a compound has not the constitutional nature which adapts it to the constitutional nature and functional powers of the living animal organs. Yet if chemistry, from her own exclusive knowledge, derived from the analysis of organic and inorganic substances, were to order the diet of man, she would be quite as likely to give us a variety of mineral substances for our daily bread, (§ 151.) as she would to give us vegetable and animal substances. (§ 465.) For

it is impossible for chemistry to tell, from *a priori* reasoning, why a piece of quartz or feldspar will not digest as well in the human stomach and afford the body as much nourishment, as a piece of flesh or bread of the same weight. But after the chemist has learned from physiology what substances will, and what will not nourish the human body, he may then, by resolving the bodies containing nourishment into their *organic elements*, (§ 122. 123.) be able to distinguish between those bodies which contain nourishment and those which do not; and in what proportions the nutrient principles exist in particular bodies; and, in this limited sphere, chemistry is certainly useful to physiology. But the moment the chemist goes beyond the organic elements and pushes his analysis to the ultimate chemical elements, or more properly speaking, to the experimental elements of inorganic chemistry, he leaves physiology behind, and is no longer serviceable to that science.

§ 763. Physiological fact has taught us that vegetable and animal substances nourish the human body, and, by analyzing these substances to their organic elements, we learn, that farina, gluten, mucilage, sugar and oil of vegetable origin, and fibrin, albumen, jelly, oil and osmazome of animal origin, are those organic elements which nourish the human body, when submitted in proper form and condition to the vital operations of our alimentary organs.—Now then, so far as chemistry can aid us in ascertaining the proportions of these organic elements, in different vegetables and animals, she is useful to the science of physiology; but when she goes farther and resolves these organic elements to the experimental elements of inorganic chemistry, she renders no service whatever to physiological science.—For instance, it is useful to the physiologist to know what proportion of sugar may be

procured from a particular kind of food: but it is of no sort of service to the science of physiology for him to know that sugar can be chemically resolved to carbon, oxygen and hydrogen. For it is not possible for him to take carbon, oxygen and hydrogen in the same proportions and form sugar for human nourishment:—nor is it possible for him to form any other substance from those elements which will answer as a substitute for sugar, or in any degree nourish the human body. Nor can this chemical analysis give him the least information concerning the mode in which the vital processes convert the sugar to chyle and blood:—nor tell him whether sugar alone will, or will not permanently nourish and sustain the human body.—Physiological experiment will tell him that it will not; (§ 748.)—but chemistry cannot tell him why.—Let chemistry, if she can, add any quantity of pure azote to the sugar, and she will find that man can live no longer on it than he could without the azote.

§ 764. A single pound of good wheat contains about ten ounces of farina, six drams of gluten and two drams of sugar: and a robust laboring man may be healthfully sustained on one pound of good wheat per day, with pure water, for any length of time he chooses, without the least physiological inconvenience:—but let him attempt to live on ten ounces of pure farina, six drams of gluten, and two drams of sugar per day, with pure water—either taken separately or mixed together, and he will soon find his appetite and strength and spirits failing and his flesh forsaking him: and death will terminate his experiment in less than a year.—Can Chemistry tell us why this is so?—Indeed she cannot! But Physiology tells us with promptitude and accuracy that wheat, in its whole substance, is constitutionally adapted to the anatomical structure and physiological powers of the aliment-

ary organs of man, but that farina and gluten and sugar, in their concentrated forms, are not:—and therefore, that the wheat, while it affords healthful nourishment to the body, also sustains the organs in digesting and appropriating that nourishment; but that the farina, gluten and sugar, though purely nutrient principles, break down the alimentary organs, destroy their functional powers, and cause the whole system to perish.

§ 765. It is therefore, nothing more than grave trifling, to tell us that, as the ultimate elements of all organic bodies are nearly the same, one substance is as good as another for human food:—and the other position (§ 762.) is of the same character. It is true that, while the alimentary organs of the human body are in perfect health, and functional integrity and vigor, the chyle is very nearly the same in its physical and chemical properties whatever may be the kind of food from which it is elaborated. (§ 465.) But there are two things in this matter, of no small importance, which are not true. In the first place, it is not true that the *vital* properties of the chyle are the same whatever may be the kind of food; nor any thing near the same. (§ 466)—In the second place, it is not true that, the health and the functional integrity and vigor of the alimentary organs, can be equally well sustained and preserved by all kinds and conditions of food; (§ 694.) and therefore it is not true, as a permanent fact, that the chyle is nearly the same, even in its physical and chemical character, in the same animal, whatever may be the kind of food from which it is formed.

§ 766. In spite of all cavilling and sophistry therefore, correct physiological science is fully established in the position, that there are the most fixed and precise constitutional laws of relation between the alimentary organs and all the particular substances of the human body, and those foreign or external substances which the Creator

designed for human food, so that, it is perfectly certain that, there are particular kinds, qualities and conditions of food, which are best adapted to sustain the highest and best condition of human nature.

Constitutional Relations of the Special Senses of Hunger and Thirst,

§ 767. The special sense of hunger, (§ 599.) like that of taste, and that of smell, is founded on the alimentary wants of the organic domain, (§ 397. 398.) and determinately established on the constitutional laws of relation between the vital organism and economy, and the quantity and quality of aliment required, and the times of alimentation.—The grand function of nutrition, appertaining to the organic domain, (§ 220.) requiring the constant supply of foreign alimentary substances to the alimentary cavity, and this supply requiring the exercise of the voluntary powers (§ 283.) appertaining to animal life, (§ 228.) it is necessary that the centre of animal perception (§ 280.) should have cognizance of the alimentary wants of the organic economy. Accordingly, when the system is in a perfectly normal, healthy and undepraved state, the stomach, which is the primary organ of external relation in regard to food, (§ 698.) is by the vital economy of the organic domain, with utmost integrity, brought into a special and peculiar physiological condition, which is perceived by the animal centre, and thus becomes the *special sense of hunger* to the animal. This special sense, in a perfectly normal, healthy and undepraved state of the system, always, with the utmost instinctive accuracy, informs us *when* the vital economy requires a fresh supply of alimentary substance; and it determinately asks for such food as is best for the sys-

tem:—but it has, in itself, no power to discern what *is best*:—for *this*, it depends entirely on those other special senses which I have described, (§ 701. 707. 708.) and on the mental powers. It only, and with unerring accuracy, tells us when the vital economy requires that the stomach should be supplied with a fresh portion of such food as is best for the system. But in a depraved state of the stomach (§ 738.) the integrity of this special sense is wholly destroyed, and the feeling which we call hunger, is no certain evidence that the vital economy really requires that a fresh supply of food should be furnished to the stomach. It is a morbid craving of the stomach for stimulation, (§ 707.) which returns at stated periods or irregularly, and with more or less capriciousness and despotism, according to the habits of the individual, and the condition of the stomach and nervous system. This kind of hunger recurs without any regard to the alimentary wants of the organic domain, and therefore, is as likely to be felt when no food is really required by the vital economy, as when it is actually needed; and its imperiousness and vehemence are, in no measure, regulated by the urgency of the real wants of the system, but wholly by the intensity of the morbid demand of the stomach for stimulation: and therefore, the supply of nourishing food to such a stomach will not satisfy its craving, unless the food contains the customary kind and quantity of stimulus.—The hunger of a depraved stomach then, is, in no respect, a true indication of the real wants of the system, and consequently, it is of the utmost importance that the integrity of the special sense of hunger should be preserved.—The same principles and reasoning are also strictly applicable to the special sense of thirst. But I shall have occasion to speak more particularly of hunger and thirst in a subsequent lecture.

APPENDIX.

NOTE A.

THE mucous coat of the alimentary canal, in a healthy state, and successfully injected, appears to consist almost entirely, of a cribriform texture of veins; these veins being commonly empty at death, present themselves as a soft spongy structure, which gives rise to the ordinary description of its sensible condition as a velvety layer. The most minute injection of the arteries scarcely makes itself visible among these veins when they are properly injected—a straggling branch only here and there exhibiting itself. The arborescence of the arteries is confined to the level beneath the venous intertexture, and is there developed to an extreme degree of minuteness, being intermixed with corresponding venous ramuscles, generally larger and more numerous than the arteries themselves. The fine venous trunks of these deeper layers have their originating extremities bent vertically towards the cavity of the gut, and by that means, receive the blood of the first venous intertexture or layer. The meshes of the first venous intertexture are exceedingly minute, and vary in a characteristic manner in the stomach, small intestines and colon. This intertexture is very different in its looks from a common vascular anastomosis, and produces in the colon, an appearance resembling a plate of metal pierced with round holes closely bordering upon each other: these holes constitute in fact, follicles or gaping orifices, the edges of which are rounded off, and their depth is that of the thickness of the venous anastomosis, being bounded below by the arterial, venous layer and by the cellular coat of the part.

Ordinary modes of examining give no evidence of the existence, in the alimentary canal, from the cardiac orifice of the stomach to near the anus of an epidermis; on the contrary they rather lead to a belief of its being absent, in consequence of the softness, tenuity and transparency

of the mucous membrane: but that it is really present may be proved by the following process:—Tear off the peritoneal coat—invert the part and inflate it to an emphysematous condition; the epidermis will then be raised as a very thin pellicle, and may be dried in that state: but as this pellicle retains the air, we hence infer that it lines the follicles, and is uninterrupted by any perforations. This epidermis, if the part be previously injected perfectly, shows dots of injecting matter, but no arborescence if it be inflated up from the veins. In so doing the villi disappear—are in fact unfolded.

The villi cannot be seen to any advantage except they be erected by an injection, in which case, those of the upper part of the small intestines are found to run into each other very much like the convolutions of the cerebrum, and to press upon each other's sides in the same way. Some of them however, are merely semi-oval plates, the transverse diameter of which exceeds the length. At the lower end of the small intestines they become simply conical projections, somewhat curved, with the edges bent in, and they retain this mechanism until they entirely disappear near the ileo-cæcal valve. In the whole length of intestine there is, however, every variety of shape, from oblong curved and serpentine ridges, to the flattened cone standing on its base; the first condition changing gradually to the last in the descent of the bowels.

Conformably to this definition of villi, none exist either in the stomach or colon, for there we have only the venous meshes. The villi of the jejunum are about the thirtieth of an inch high, and those of the ileum about one sixtieth.

The superficial venous layer has great regularity in the ileum and the conical villi stand out beautifully from its partitions, or, in equivalent language, from the divisions of the follicles. In the upper part of the small intestine the follicles are in equal number to what they are in the ileum; the regularity of their arrangement being interrupted by the long serpentine and oval villi; but invariably the same venous intertexture exists and forms in both, the chief bulk of the villi by passing into them.

In the stomach the *follicles* vary much in size, and there is an arrangement whereby many of the smaller ones are seen to open into the larger; on an average about 225 are found upon every eighth of an inch square, which would give, of course, to an inch square, sixty-four times that amount or 14400 follicles; and, conceding the whole stomach to present an area of 90 inches, which is probably below the mark when this organ is moderately distended, as exhibited in the preparation upon which this calculation is founded, the entire number of follicles is *one million two hundred and ninety-six thousand*.

The greater uniformity of size of these follicles in the colon, and its even surface, enable us to count them with more certainty; and they appear to exist at the beginning of this gut, at the rate of about 400 for every eighth of an inch square; and in the sigmoid flexure at the rate of about 200 to the same area:—they become in fact both smaller and less numerous in descending towards the anus.

Admitting the entire area of the colon to be 500 inches, and 19200 of these follicles, on an average, to exist on every square inch, the aggregate number will be *nine millions six hundred thousand*.

Again, estimating the whole area of the mucous coat of the small intestines at 1440 inches, and allowing for interruption occasioned by villi, about twenty-five thousand follicles are found upon every square inch, and the two numbers multiplied produce *thirty-six millions*.

The entire number of follicles in the whole alimentary canal is, by the preceding estimate, forty-six millions eight hundred and ninety-six thousand. I am very far from pretending to have counted them all, but have made an approximation to the actual number by observing sections of different portions of the same subject, and verifying the observations upon other subjects. The external surface of the cutis vera presents, as it were, in outline the same arrangement; the venous reticular intertexture appearing broader, not quite so perfect, and more shallow, and forming the papillæ: but as additional experiments are wanting it may be passed over with this transient notice; perhaps indeed, a more skilful hand in adopting the hint may perfect the details.

In the stomach, the largest of these follicles is about one ninety-eighth of an inch in diameter and the smallest about one four hundred and ninetieth. In the colon the largest is about one two hundred and forty-fifth of an inch in diameter; and the smallest about one four hundred and ninetieth. In the small intestines their size varies in about the same ratio as in the colon, but they are much more irregular in shape, being scattered more in groups in consequence of the villi intervening; some, of them penetrate obliquely towards the foundations of the villi, hence when examined from the exterior, their distribution is more regular, and they are seen lodged in the cellular coat of the gut.

I have endeavored to keep the estimate of the number of follicles below what other calculators would make it upon an observation of my preparations and a fair measurement of the area of the alimentary canal, lest the number should seem excessive and incredible: I have therefore the most reasonable assurance of being within bounds on that point. I may now ask their use? Is it to secrete or absorb? If they are simply secernents of mucous, the number, one would think, much greater

than so limited a secretion requires,—moreover, why is it that they become smaller and less numerous towards the lower end of the large intestine, where greater lubrication is required for hardened fæces; in addition, are not the glands of Brunner (*solitariae*) and of Peyer (*agminatæ*) amply sufficient to furnish the required means? Again, after most sedulous observations upon the villi of all kinds, finely erected by my injections, and placed under most accurate, simple and compound microscopes, I find invariably a polished reflecting surface, uninterrupted by foramina, either at their ends or sides, while many of these follicles are found passing obliquely into their bases. An excellent Woollaston's doublet, which makes the villi of the ileum appear an inch long, exhibits them with a polished translucent surface, without foramina except where a villus, from accident, has been broken, a contingency readily recognised by one in the habit of viewing them. Finally, if the lacteal foramina of Lieberkuhn and others, do exist in fact, why is it that the raising of the intestinal epidermis by inflation does not exhibit this foramina by the air escaping through them, but on the contrary admits of a dried preparation in that state, the villi being completely effaced.

Taking into consideration these several objections to the theory of the follicles being secreting orifices, it appears to me that a better idea of their use is called for, which suggestion is submitted to the profession with the hope that a more capable person will remove the difficulty by additional confirmation of preceding theories, or by the invention of a new one; for my own part, I am much inclined to adopt the opinion of their absorbing faculties.

Notwithstanding the facility with which I can detect these follicles, I have failed entirely under various means of examination, in finding any orifices to Peyer's glands, in the dried intestines; they appear to be merely small lenticular excavations in its substance, and wherever a cluster of them exists, it disturbs the arrangement of the villi, and gives to them, a scattering, unequal distribution. I would also suggest very respectfully to anatomists whether our knowledge in regard to them, is sufficiently exact to render further inquiry useless. For my own part, it appears that this subject requires some additional attention.

Remarks on the structure of the mucous coat of the alimentary canal, by W. E. Horner, M. D., Professor of Anatomy in the University of Pennsylvania.

ERRATA.

Page 54, second line from the bottom, read "which lie between," &c.

" 98, second line from the top, read (Fig. 41.)

" 112, bottom line, reference, read (§ 170.)

" 124, fifteenth line from the bottom, after "development" read
reference (§ 174.)

" 136, tenth line from the top, after "each other," read reference
(§ 174.)

" 144, second and fourth lines from the bottom, read "anastomoses."

" 169, sixteenth line from the bottom, read "special organs."

" 170, twentieth line from the bottom, read "in the corpus callosum."

" 183, sixth line from the bottom, read "respiratory and alimentary."

" 198, for the number of the second section, read (§ 313.)

" 228, bottom line, read (fig. 33.)

There are probably some other typographical errors which have been overlooked.

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HUMAN CLOTHING.

Its Principle. Its Primitive State. VI. SUNDAY.—*The Emptiness of Human Attainments.* Its Ancient History. Commercial History of the Raw Material. The Silk Manufacture.—Its Modern History. History of Mechanical Contrivances connected with it. Rearing of the Cocoons, &c. The Cotton Manufacture.—Its Foreign History. VII. SUNDAY.—*The Intellectual and Moral Enjoyments of Heaven.* The Cotton Manufacture.—Its British History. Improvement of Machinery. Its American History.—Introduction of Steam Power. The Woollen Manufacture.—Its History. The Art of Bleaching. The Art of Dyeing.—Its Origin and Ancient History. VIII. SUNDAY.—*The Social and Religious Enjoyments of Heaven.* The Art of Dyeing.—Its Modern History. Its Chemical Principles.

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Of Applying Superficial Color—Painting, Colors, Preparation, Application, Crayons, Water Colors, Distemper, Fresco, Encaustic Painting, Oil Painting, Varnishing, Japanning, Polishing, Lacquering, Gilding. *Of Changing Intrinsic Color*—Bleaching, Photogenic Drawing, Dyeing, Mordants, Dyes, Calico Printing.

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Arts of Heating and Ventilation.

Production of Heat—Fuel, Weight of Fuel, Combustible Matter of Fuel, Water in Fuel, Charcoal, *Communication of Heat*, Radiated and Conducted Heat, Fire in the Open Air, Fire Places, Admission of Cold Air, Open Fires, Franklin Stove, Rumford Fire Place, Double Fire Place, Coal Grate, Anthracite Grate, Burns' Grate, Building a Fire, Furnaces, Stoves, Russian Stove, Cockle, Cellar Stoves, and Air Flues, Heating by Water, Heating by Steam, *Retention of Heat*, Causes of Loss, Crevices, Chimneys, Entries and Sky Lights, Windows, *Ventilation*, Objects, Modes, Ventilators, Culverts, Smoky Rooms, Damp Chimneys, Large Fire

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CHAPTER XIII.

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Arts of Induration by Heat.

Bricks, Tiles, Terra Cotta, Crucibles, Pottery, Operations, Stone Ware, White Ware, Throwing, Pressing, Casting, Burning, Printing, Glazing, China Ware, European Porcelain, Etruscan Vases.

A FAMILIAR TREATISE ON THE CONSTITUTION OF THE UNITED STATES, by the Hon. JUDGE STORY, L L. D., *Author of 'Commentaries on the Constitution,' &c.*

LIFE OF DR. FRANKLIN.

SELECTIONS FROM THE WRITINGS OF FRANKLIN, by JARED SPARKS, L L. D., *Professor of History in Harvard University, Author of 'the Life and Writings of Washington,' 'the Life and Writings of Franklin,' &c. &c.*

CHRISTIANITY AND KNOWLEDGE, by the Rev. ROYAL ROBBINS.

The design of this Work is to show what Christianity has done for the human intellect, and what that has done for Christianity.

THE LORD OF THE SOIL, OR, PICTURES OF AGRICULTURAL LIFE; by Rev. WARREN BURTON, *Author of 'The District School as it Was,' &c. &c.*

SCIENCE AND THE ARTS, by the Rev. ALONZO POTTER, D. D., *Professor of Moral Philosophy and Rhetoric, in Union College, Schenectady, N. Y.*

The design of this Work is to call attention to the fact that the Arts are the result of *intelligence*—that they have, each one its *principles* or *theory*—that these principles are furnished by *Science*, and that he, therefore, who would understand the Arts, must know something of *Science*; while, on the other hand, he who would see the true power and worth of *Science* ought to study it in its applications. The work will be made up of *facts*, illustrating and enforcing these views—so arranged as to exhibit the invariable connexion between *processes* in *Art*, and *laws* in *Nature*. The importance of such a work requires no comment.

AGRICULTURE, by the Hon. JUDGE BUEL, of Albany, *Editor of 'the Cultivator.'*

This Work is intended as an aid to the *Young Farmer*, and from the known character of the gentleman who has it in hand, there can be no doubt but that it will be executed in a highly satisfactory manner. The following, among other subjects, will be therein treated of, viz.

1. The Importance of Agriculture to a Nation.
2. Improvement in our Agriculture practicable and necessary.
3. Some of the principles of the new and improved Husbandry.
4. Agriculture considered as an Employment.
5. Earths and Soils.
6. Improvement of the Soil.
7. Analogy between Animal and Vegetable Nutrition.
8. Further Improvement of the Soil.
9. " " by Manures, Animal and Vegetable.
10. " " by Mineral Manures.
11. Principles and Operations of Draining.
12. Principles of Tillage.
13. Operations of Tillage, &c. &c.

Due notice will also be taken of alternating crops, root husbandry, mixed husbandry, the management of pasture and meadow lands, the garden, orchard, &c.

Cuts, illustrative of the various operations spoken of and recommended, will be given.

GEOLOGY AND MINERALOGY, by CHARLES T. JACKSON, M. D., *Geological Surveyor of Maine and Rhode Island.*

STATISTICS OF THE UNITED STATES, by GEORGE TUCKER, *Professor of Moral Philosophy in the University of Virginia, Author of 'the Life of Jefferson,' &c. &c.*

AMERICAN TREES AND PLANTS, used for medicinal and economical purposes and employed in the Arts, with numerous engravings ; by Professor JACOB BIGELOW, *Author of 'Plants of Boston,' 'Medical Botany,' &c. &c.*

MORAL EFFECTS OF INTERNAL IMPROVEMENTS, by ROBERT RANTOUL, Jr., Esq.

LIVES OF THE REFORMERS, by Rev. ROMEO ELTON, *Professor of Languages in Brown University.*

BIOGRAPHICAL SKETCHES OF DISTINGUISHED FEMALES, by Mrs. EMMA C. EMBURY, of *Brooklyn, N. Y.*

SKETCHES OF AMERICAN CHARACTER, by Mrs. SARAH J. HALE, *Editor of 'the Ladies' Book,' Author of the 'Ladies' Wreath,' 'Flora's Interpreter,' &c. &c.*

DO RIGHT AND HAVE RIGHT, by Mrs. ALMIRA H. LINCOLN PHELPS, *Principal of the Literary Department of the Young Ladies' Seminary, at West Chester, Pa., formerly of the Troy Seminary, N. Y., Author of 'Familiar Lectures on Botany,' 'Female Student,' &c.*

The object of this Work may be gathered from the following remarks of Mrs. Phelps. "A popular work on the principles of law, with stories illustrating these principles, might be very profitable to people in common life, as well as to children. The ward cheated by a guardian, the *widow* imposed on by administrators or executors, the *wife* abandoned by a husband, with whom she had trusted her paternal inheritance, the *partner* in business, overreached by his crafty associate, for want of a knowledge of the operations of the law,—all these might be exhibited in such a way as to teach the necessity of legal knowledge to both sexes, and to all ages and classes."

SCENES IN THE LIFE OF JOANNA OF SICILY, by Mrs. E. F. ELLET, of *Columbia, S. C.*

This is written with a view to young readers, and for the purpose of illustrating important historical events.

The Publishers have also in preparation for this Series, a History of the United States, and of other Countries, a History of the Aborigines of our Country, a History of Inventions, Works on Botany, Natural History, &c. &c. Many distinguished writers, not here mentioned, have been engaged, whose names will be in due time announced, although at present, we do not feel at liberty to make them public.

Among the works prepared, and in a state of forwardness, for the *Juvenile Series* are the following, viz.

MEANS AND ENDS, OR SELF TRAINING, by Miss CAROLINE SEDGWICK, *Author of 'The Poor Rich Man, and Rich Poor Man,' 'Live and Let Live,' 'Home,' &c. &c.*

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SELECTIONS FROM THE WORKS OF DR. AIKIN, with a *Sketch of his Life*, by Mrs. HALE.

CHEMISTRY FOR BEGINNERS, by BENJAMIN SILLIMAN, Jr., *Assistant in the Department of Chemistry, Mineralogy, and Geology in Yale College*; aided by Professor SILLIMAN.

MY SCHOOLS AND MY TEACHERS, by Mrs. A. H. LINCOLN PHELPS.

The author's design, in this work, is to describe the Common Schools as they were in New-England at the beginning of the present century ; to delineate the peculiar characters of different Teachers ; and to give a sketch of her various school companions, with their progress in after life, endeavoring thereby to show that the child, while at school, is forming the future man, or woman.

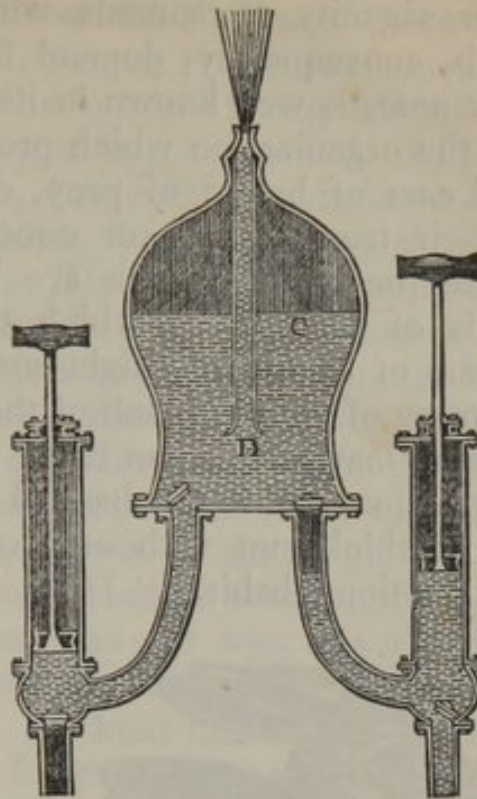
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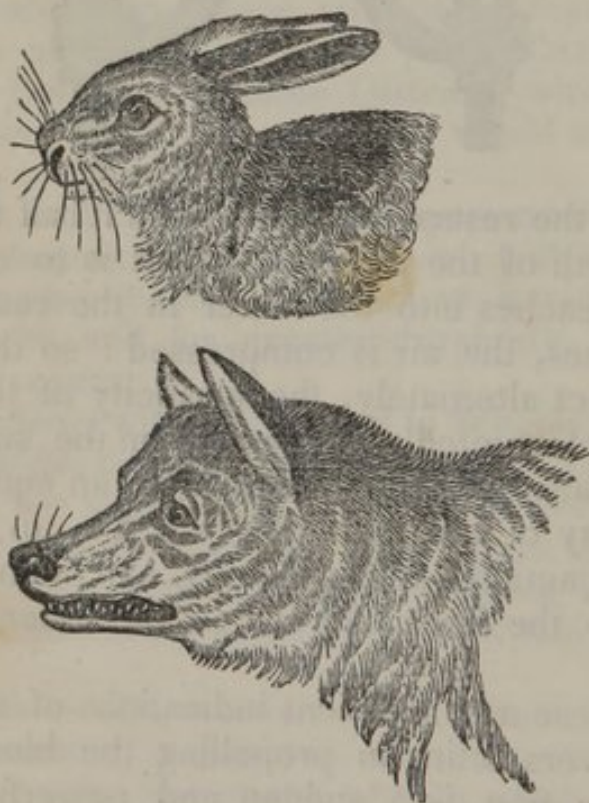


carried into the reservoir, and they fill it half full of water, C; the mouth of the pipe, D, which is to convey away the water, reaches into the water in the reservoir. As the water rises, the air is compressed: so that, although the pumps act alternately, the elasticity of the contained air acts uninterruptedly in pressing on the surface of the water, and raising it by the tube, D, in an equable stream. The elasticity of the contained air, fills up the interval between the actions of the pumps, and admits of no interruption to the force with which the water is propelled upwards.

Surely these are sufficient indications of the necessity of three powers acting in propelling the blood from the heart. The first, is a sudden and powerful action of the ventricle: the second, is a contraction of the artery, somewhat similar, excited by its distention: the third, though a property independent of life, is a power permitting no interval or alternation; it is the elasticity of the coats of the artery: and these three powers, duly adjusted, keep up a continued stream in the blood-vessels. It is true, that when an artery is wounded, the blood flows

The superior sagacity of animals which hunt their prey, and which, consequently, depend for their livelihood upon their *nose*, is well known in its use; but not at all known in the organization which produces it.

The external *ears* of beasts of prey, of lions, tigers, wolves, have their trumpet-part, or concavity, standing forward, to seize the sounds which are before them—viz., the sounds of the animals which they pursue or watch. The ears of animals of flight are turned backward, to give notice of the approach of their enemy from behind, whence he may steal upon them unseen. This is a critical distinction, and is mechanical; but it may be suggested, and, I think, not without probability, that it is the effect of continual habit.



[Heads of the hare and wolf, showing the different manner in which the ears are turned.—AM. ED.]

The *eyes* of animals which follow their prey by night, as cats, owls, &c., possess a faculty not given to those of other species, namely, of closing the pupil *entirely*.

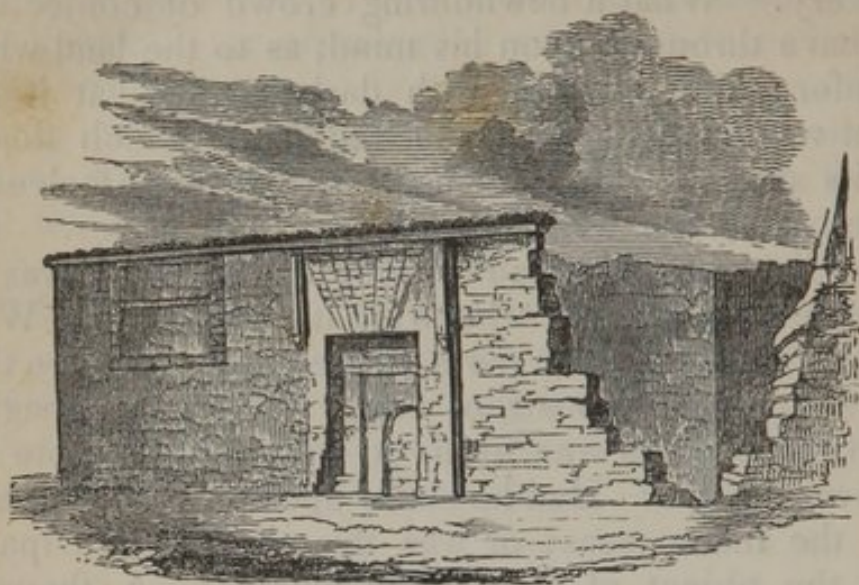
It is difficult even for the imagination to conceive the feelings of such a man, at the moment of so sublime a discovery. What a bewildering crowd of conjectures must have thronged upon his mind, as to the land which lay before him, covered with darkness. That it was fruitful was evident from the vegetables which floated from its shores. He thought, too, that he perceived in the balmy air the fragrance of aromatic groves. The moving light which he had beheld, proved that it was the residence of man. But what were its inhabitants? Were they like those of other parts of the globe; or were they some strange and monstrous race, such as the imagination in those times was prone to give to all remote and unknown regions? Had he come upon some wild island, far in the Indian seas; or was this the famed Cipango itself, the object of his golden fancies? A thousand speculations of the kind must have swarmed upon him, as he watched for the night to pass away; wondering whether the morning light would reveal a savage wilderness, or dawn upon spicy groves, and glittering fanes, and gilded cities, and all the splendors of oriental civilization.

CHAPTER XI.

First Landing of Columbus in the New World.—Cruise among the Bahama Islands.—Discovery of Cuba and Hispaniola. [1492.]

WHEN the day dawned, Columbus saw before him a level and beautiful island, several leagues in extent, of great freshness and verdure, and covered with trees like a continual orchard. Though every thing appeared in the wild luxuriance of untamed nature, yet the island was evidently populous, for the inhabitants were seen issuing from the woods, and running from all parts to the shore. They were all perfectly naked, and from their attitudes

residence of Martin Alonzo or Vicente Yañez Pinzon, in the time of Columbus.



We now arrived at the church of St. George, in the porch of which Columbus first proclaimed to the inhabitants of Palos the order of the sovereigns, that they should furnish him with ships for his great voyage of discovery. This edifice has lately been thoroughly repaired, and, being of solid mason-work, promises to stand for ages, a monument of the discoverers. It stands outside of the village, on the brow of a hill, looking along a little valley toward the river. The remains of a Moorish arch prove it to have been a mosque in former times ; just above it, on the crest of the hill, is the ruin of a Moorish castle.

I paused in the porch, and endeavored to recall the interesting scene that had taken place there, when Columbus, accompanied by the zealous friar Juan Perez, caused the public notary to read the royal order in presence of the astonished *alcaldes*, *regidores*, and *alguazils* ; but it is difficult to conceive the consternation that must have been struck into so remote a little community, by this sudden apparition of an entire stranger among them, bearing a command that they should put their persons and ships at his disposal, and sail with him away into the unknown wilderness of the ocean.

The interior of the church has nothing remarkable,

work of creation and the work of grace revealed in the word of God. Proofs corroborative of the authenticity of the Bible, have been gathered from those very sources which formerly were applied to by the skeptic for his sharpest weapons ; and at this moment, (such is the security with which Christianity may regard the progress of knowledge,) there does not exist in our own country, nor, so far as I am aware, in any other, one philosopher of eminence who has ventured to confront Christianity and philosophy, as manifestly contradictory. May we not venture to hope that, in a very short time, the weak darts of minor spirits, which from time to time are still permitted to assail our bulwarks, will be also quenched, and the glorious Gospel, set free from all the oppositions of science falsely so called, shall walk hand in hand over the earth with a philosophy always growing in humility, because every day becoming more genuine. C. J. C. D.

TWELFTH WEEK—MONDAY.

VEGETABLE SUBSTANCES USED FOR WEAVING.—THE COTTON-PLANT.

THE cotton-plant, another vegetable substance, extensively used in manufactures, differs materially from that already described, in its properties, appearance, and habits. Instead of being generally diffused over temperate climates, it belongs more properly to the torrid zone, and the regions bordering on it ; and instead of being chiefly confined to one species, as to its peculiar and useful qualities, its varieties seem scarcely to have any limit, extending from an herb* of a foot or two in height, to a tree†

* *Gossypium herbaceum*, or common herbaceous cotton-plant.

† *Bombax ceiba*, or American silk cotton-tree.—[The Baobab, or *Adansonia digitata*, an enormous and long-lived tree, also belongs to this family. But it is incorrect to call these trees "varieties" of the cotton plant. They are nearly allied to it, indeed, but they stand in different divisions of the great order of *malvaceæ*, or mallows ; and the downy contents of their pods are of little use compared with true cotton.—AM. ED.]

Coup de main, (French term,) a military expression, denoting an instantaneous, sudden, unexpected attack upon an enemy.

Dulce et decorum est pro patria mori, It is delightful and glorious to die for one's country.

Effigies Seb. Caboti Angli filii Joannis Caboti militis aurati. As will be seen by the text, where this inscription occurs, (p. 121,) there is an ambiguity in the application of the last two words. The other part of the inscription, may be rendered, "the portrait (or likeness) of Sebastian Cabot, of England, son of John Cabot." *Miles*, or *militis*, means, literally, a warrior, or soldier, or officer of the army; and in the English law, sometimes indicates a knight. *Auratus*, or *aurati*, means gilt, gilded, or decked with gold. *Eques* means a horseman, or knight, who was frequently called *eques auratus*, because, anciently, none but knights were allowed to beautify their armor, and other habiliments, with gold.

En masse, in a body, in the mass, altogether.

Eques, and *Eques auratus*. See *Effigies*.

Fascine, (pl. *fascines*,) a bundle of fagots, or small branches of trees, or sticks of wood, bound together, for filling ditches, &c.

Formula, (pl. *formulae*,) a prescribed form or order.

Geodætic, relating to the art of measuring surfaces.

Gramina, grasses.

Green Mountain Boys, a term applied, during the Revolutionary War, to the inhabitants of Vermont, (Green Mountain,) particularly those who were in the army.

Gymnotus, the electric eel.

Habeas Corpus, "you may have the body." A writ, as it has been aptly termed, of personal freedom; which secures, to any individual, who may be imprisoned, the privilege of having his cause immediately removed to the highest court, that the judges may decide whether there is ground for his imprisonment or not.

Hipparchus, a celebrated mathematician and astronomer of Nicæa, in Bithynia, who died 125 years before the Christian era. He was the first after Thales and Sulpicius Gallus, who found out the exact time of eclipses, of which he made a calculation for 600 years. He is supposed to have been the first, who reduced astronomy to a science, and prosecuted the study of it systematically.

Loyalists, Royalists, Refugees, and Tories. In the times of the Revolution, these terms were used as technical or party names, and were sometimes applied indiscriminately. Strictly speaking, however, *Loyalists*, were those whose feelings or opinions were in favor of the mother country, but who declined taking part in the Revolution; *Royalists*, were those who preferred or favored, a kingly government; *Refugees*, were those who fled from the country and sought the protection of the British; and *Tories*, were those, who actually opposed the war, and took part with the enemy, aiding them by all the means in their power.

Magnetic Variation, a deviation of the needle in the mariner's compass, from an exact North and South direction.

Master-at-arms, an officer appointed to take charge of the small arms in a ship of war, and to teach the officers and crew the exercise of

ring it all the time. Of course I do not make it every time it is wanted, for sometimes, when I want it extra good, I boil and stir it a full hour, and then I put it away in a close vessel and in a cool place. For Raymond, or for any one getting well, and free from fever, I put in a third wheat flour, and half milk. You see it is a very simple process, sir."

"Yes—simple enough. But it is to these simple processes that people will not give their attention."

Mary had the happiness of seeing Raymond sitting up before their parents returned, and when they drove into the great gate, and up the lane, he was in his rocking-chair by the window, watching for them. They had heard of his illness, and were most thankful to find him so far recovered. The Doctor chanced to be present when they arrived. "O, Doctor!" said Mrs. Bond, after the first greetings were over, "how shall I ever be grateful enough to you?"

"I have done very little, Mrs. Bond," replied the honest Doctor. "In Raymond's case, medicine could do little or nothing. Nature had been overtasked, and wanted rest and soothing. Under God, Raymond owes his recovery to Mary."

"O, mother!" exclaimed Raymond, bursting into tears, "she is the best sister in the world!"

"She is the best sister in the *two* worlds!" cried little Grace Bond, a child of five years old.

A source of true comfort and happiness is such a child and such a sister as Mary Bond!—a light

us, as soon as we are missed ; let us keep on and perhaps we may find some other path."

The poor children proceeded on their course, unconscious that every step was taking them deeper into the forest, until, completely bewildered by the thick darkness, and overcome with fatigue, they could go no further. "Let us pray to God, and then we can lie down, and die in peace," said George ; and the innocent children knelt down on the fallen leaves, and lisped their simple prayers, as they were accustomed to do at their mother's side.

"We must try to find some shelter, George," said Kate, as they arose from their knees, "this chill air will kill you, even if we escape the wild beasts." As she spoke, the light of a young moon which faintly illumined the depths of the wood, enabled her to discover a hollow log lying near. Tearing off some branches from the brittle hemlock tree, she piled them around the log, in such a manner, as to form a sort of penthouse ; and, placing George within the more effectual shelter of the log, she lay down by his side. Worn with fatigue, notwithstanding their fears, the children soon fell into a profound sleep ; and the beams of the morning sun, shining through the branches which formed their covering, first awoke them from their peaceful slumbers.

Their little hearts swelled with gratitude to the merciful God, who had preserved them through the perils of the night, and the morning hymn which was wont to resound within the walls of their

