On the fundamental laws of the organic molecular actions of the animal organism, identical with those of rational mechanics : an introductory lecture / by Samuel Jackson.

ON THE

FUNDAMENTAL LAWS

OF THE

ORGANIC MOLECULAR ACTIONS

OF THE

ANIMAL ORGANISM,

IDENTICAL WITH THOSE OF

RATIONAL MECHANICS:

AN INTRODUCTORY LECTURE.

BY

SAMUEL JACKSON, M. D.,

PROFESSOR OF THE INSTITUTES OF MEDICINE IN THE UNIVERSITY OF PENNSYLVANIA.

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At a meeting of the Medical Class of the University of Pennsylvania, held October 18, 1856, for the purpose of requesting for publication a copy of the Introductory Lecture of Professor Samuel Jackson, M. D., Mr. Jno. K. Ruffin, of North Carolina, was called to the chair, and Mr. Thomas A. Catchings, of Mississippi, appointed secretary. The Chair having stated the object of the meeting, it was, on motion—

Resolved, That a Committee of one from each State, Province, and Country represented in the Class, be appointed to carry out the wishes of the Class.

And the following gentlemen were appointed:—

Committee.

J. Russell Little, New Hampshire.
D. L. Huntington, Massachusetts.
W. L. Perkins, Connecticut.
Jno. Cooper, New York.
J. M. Kollock, New Jersey.
J. H. Hutchinson, Pennsylvania.
W. J. Hitch, Delaware.
G. W. Purnell, Maryland.
J. Bragg, Virginia.
J. M. Bynum, North Carolina.
R. R. Gibbs, South Carolina.
J. R. Troup, Georgia.
S. R. Williams, Florida.
Walker Curry, Alabama.
L. Holmes, Mississippi.
J. C. Bolton, Louisiana.
W. H. Hawkins, Arkansas.
C. B. Jennings, Iowa.
L. L. Bowers, Illinois.
G. Bonham Wood, Indiana.
J. L. Grigsby, Kentucky.
J. E. Dixon, Tennessee.
A. W. James, Ohio.
W. J. Craigan, District of Columbia.
J. F. Cotillo, Cuba.
P. Redondo, Spain.
A. H. Chumdler, New Brunswick.
C. Gray, Nova Scotia.
J. Winton, East Indies.
J. E. Arjona, New Grenada.
T. W. Johnson, Bahamas.
H. Lösch, Bavaria.

CORRESPONDENCE.

University of Pennsylvania,
October 22, 1856.

Dear Sir: The undersigned have been appointed a special committee to solicit for publication a copy of your Lecture, introductory to the course on the Institutes of Medicine.

The marked attention with which it was listened to by the Class, is a proof that it cannot fail to be read with interest by the profession.

Hoping that you may accede to our request,

We remain, with sentiments of high respect, truly yours,

James H. Hutchinson,
S. R. Williams,
J. R. Troup,
George W. Purnell,
Joseph M. Bynum,
Committee.

To SAMUEL JACKSON, M. D.,
Professor of the Institutes of Medicine.

Philadelphia, *November* 20, 1856.

Gentlemen: Your note requesting, on the part of the Medical Class, the publication of my Introductory Lecture, was duly received.

The views brought forward in it are novel. I believe them to be true and important. As my Lecture was hastily written for the occasion, some revision was required to fit it for the press.

Various causes have prevented me from attending earlier to this duty. A copy is now at your disposal, and it gratifies me to be able to comply with the wish of the Class, so kindly expressed by yourselves.

Believe me, very sincerely,

Yours, &c.,
SAMUEL JACKSON.

To Messrs.
James H. Hutchinson,
S. R. Williams,
J. R. Troup,
George W. Purnell,
Joseph M. Bynum,
Committee.

INTRODUCTORY LECTURE.

THIS lecture will be strictly preliminary to my course. The time allotted in this country to medical instruction being too limited to embrace the expanded scope of the science, as developed in the present day, a single dissertation on extraneous topics could only be delivered at the expense of matters of more immediate interest and importance. I shall, therefore, commence at once with the investigation and discussion of the numerous complicated questions concerning the phenomena, facts, and laws of life, subjects statical and dynamical, that form the department of medical science, appropriated to the chair, which is committed to my charge, in this time-honored institution.

The "Institutes of Medicine" is the title of this chair. To teach the institutes of medicine is its duty—its proper business. In the first place, let us then ascertain the meaning of the term "Institutes of Medicine." What are the objects they are intended to fulfil? What is the utility to be derived from this cultivation? The information conveyed by the answer to these questions is indispensable to such of you as are in attendance for the first time on this course, and a repetition of the subject may serve to impress it more lastingly on the memory of those to whom it has already been explained in previous sessions.

The term Institute means established law, settled order, and is equivalent to principles, maxims, precepts. The word Institution is nearly synonymous; it signifies "law or system of the elements, or rules of an art or science." The same term is used in the same meaning in law, medicine, and religion. Thus we have the Institutes of the Roman law, which comprise the fundamental principles of the *Corpus Juris Civilis*. The Institutes of Boerhaave expound the principles on which he based his system of

medicine. Calvin embodied his religious doctrines in a work which he entitled—*Institutio Christianæ Religionis.* Hence, the Institutes of Medicine constitute the scientific department of medicine.

The province of this chair is to investigate medical facts and organic phenomena in their scientific aspect, and their scientific correlations. The examination of organic phenomena, with a view to determine their true nature, their relations to each other, and to establish or ascertain the laws to which living organisms are subordinated in their normal or physiological and their abnormal or pathological conditions, will form the main purport—the cardinal aim of my lectures. If this object is at all attainable (and there exists, as we shall see hereafter, no insurmountable obstacle to prevent it), medicine must cease to be an empirical art, but assume its legitimate position as one of the positive sciences.

The above prefatory explanation was the more necessary, in view of the mistaken opinions that prevail on the important subject under consideration. The Institutes of Medicine are often confounded with Physiology; medical students having been led into this error in consequence of physiology being taught in chairs of our medical schools, having the title of "the Institutes of Medicine."

Physiology is one of the organic sciences. It comprises the knowledge of the organs, functions, and forces of living beings in their normal state. It is, however, applicable to, and has relations with, all the organic sciences, and, in consequence, belongs as an auxiliary department to botany, zoology, hygiene, and sociology, as well as to medicine. It is related to medicine exclusively in the scientific development of the latter. As an art, medicine may be practised wholly independent of physiology. Medicine, as such, was already perfectly developed in the days of Galen, 1900 years ago, and in those of Hippocrates even, about 500 years earlier. As a practical art, conducted according to certain rules and methods of treatment, based on observation and experience, as exemplified in the works of Hippocrates, Galen, Celsus, Aretaeus, and Oribasius, it may well be questioned whether modern medicine surpasses that of the ancients. We possess, it is true, a better replenished armory; are furnished

with more effective weapons or instruments, and more potent agents, contributed for several centuries, from the vegetable, animal, and mineral kingdoms, and by chemical processes, so as to place at our command a vastly superior *materia medica* and pharmacy than was known to the physicians of Greece and Rome, but it cannot be denied that the latter were most skilful empirical practitioners. Yet, highly advanced as the medical art of the ancients was, it was not based on scientific principles, because wholly independent of physiology, which science was unknown to them.

Medicine, after its revival in the middle ages, presented an identical progression. It commenced in observation and expanded by rational and cultivated experience into an empirical art, which, in the works of Fernelius, Riverius, Sydenham, Morton, Baglivi —all and each of them models of practical excellence—is displayed in methods and rules, arranged into system and order of great perfection. This progress of the medical art was effected again, without any aid borrowed from physiology. Even at the present time, most able, solid, and expert practitioners, are either ignorant or but slightly acquainted with physiology. It was not until the middle of the last century, that physiology first assumed its position as a department of science. And only within the last twenty-five years has it been so far advanced as to become available to the explanation of pathological phenomena and therapeutical applications.

Medicine, we have thus seen, long since reached a high state of perfection, as an art, yet it remained exceedingly defective, and could not rise by its own powers and researches to the dignity of a defined, positive science. To elevate it to that lofty position, was reserved for physiology, whose important aim is to evolve from facts of observation, those principles, that are embodied in the "Institutes of Medicine" as the general and special laws of the living organism. These laws must form the basis of medicine as a science.

A distinction has been drawn in the preceding discussion between art and science. It is necessary that you should clearly understand the difference between them. Art proceeds from the senses through observation. It is empirical, and consists of facts systemized and reduced to rules and maxims, which may be

learned by rote and practised conformably to a certain routine. It never penetrates to the intimate nature of things, but is arrested at their exterior. In reference to the practice of mere art, the intellectual faculties, except memory, remain passive. A manufacturing chemist may succeed in producing acids, salts, chlorides, and other preparations of any given quality, or in any quantity desired, from instruction given to him, though wholly ignorant of the scientific principles of the chemical processes which he carries out. A musician may be an exquisite performer on an instrument, having no conception of music as a science. And a physician may treat successfully fevers, inflammations, and other diseases, such as have determinate stages and periods, or other routine conditions, from the knowledge acquired from practical works, the instructions of preceptors, and experience, yet have no clear insight into the inmost nature and fundamental causes of the phenomena under his observation. He is then a medical practitioner, but not a scientific physician.

Science is an emanation of the Divine Intelligence. It is the exalted privilege of man's intellectual faculties, to aspire at the comprehension and interpretation of the ideas of the Creative Mind, expressed in the physical forces and organic laws that govern the phenomena of nature, their formation, actions, movements, and conditions, such as they are manifested in the matter, animate and inanimate, of this globe and the whole universe. Our senses are so endowed as to have cognizance of the existence of the varied phenomena, of which nature's forces and laws are the efficient causes. The intellectual faculties find in the fixed co-ordination of these phenomena, and the equal stability of their characteristic differences an evidence of the forces and laws of nature. The knowledge of these constitutes science, which is revealed to the persistent efforts of man's understanding, and the rational prevision of his genius. Science in the view here represented, has existed from the creation: it is eternal. Scientific knowledge is but the progressive discovery and perception of the principles and positive laws of nature. It is slow, of recent date, and as yet exceedingly imperfect. That of astronomy is the most advanced and probably is completed. This arises from its facts being simple, and its laws of a general character. There are three elementary laws to be considered by the astronomer, namely: two antago-

nistic forces, the centrifugal and centripetal, and a third, the interfering attractions of the masses of the heavenly bodies.

Kepler worked out the mechanical laws of the planetary orbits, as laid down in the most important of his works, entitled: "Astronomia nova, seu Physica coelestis."

Newton penetrated to a clearer conception of the Creative Idea, and had revealed to him the fundamental mechanical law of the universe, the law of gravitation. The establishment of these laws has given to astronomical calculations absolute certainty. And whenever the fundamental laws of other sciences shall be as well settled, these sciences will acquire the same positiveness as astronomy.

In proportion as the facts and laws of science have a less general application, but are individual and special, the phenomena to which they relate appear more complex, and become more difficult to comprehend, and to resolve into their components. The investigation of such complicated phenomena is necessarily slow and laborious, and the perfection of a knowledge of them may require indefinite time, probably centuries. Such being the character of all organic sciences, and especially of medicine, the most abstruse and intricate of all, it will be the latest in arriving at full maturity.

Our divisions of science find no analogy in nature: they are artificial. The separation of sciences into distinct branches is a necessity arising from the incapacity of the human intellect, to comprehend the one universal science of Creation, in a single grasp. The mind, compelled to work on isolated groups of modified phenomena, is led to regard them as independent of each other, and is induced to classify them and assign to each a distinct place. But the progressive development of scientific knowledge reveals more and more the unity of Creation, demonstrating intelligibly, that the various phenomena of nature are not isolated facts, but closely linked together, mutually connected, and passing into one another. From this intimate association and correspondence, it may be justly inferred, that when any primary and general laws govern any one class or group of actions, the same or similar laws are applicable to all analogous phenomena. The application of this principle to the physiological sciences, has thrown on the obscure phenomena of life a flood of light. The time has not yet passed, when man was looked on by physiologists and

physicians as standing apart from all other natural bodies, and not subject to the ordinary laws of nature. All the actions and functions of his economy were, by way of explanation, summarily termed "vital actions." It is now, however, known that all the functions of organic or vegetative life, are physical, chemical, and mechanical. Those of the nervous spinal system are dynamical; and of the cerebral organ psychological.

The laws established in physics, chemistry, mechanics, and dynamics, are applicable to the corresponding phenomena in man and other living beings. Physiology and medicine enter therefore necessarily into the circle of the positive sciences. They must be cultivated in the same spirit, by the same methods of observation, and processes of experimentation and reasoning.

The object of our discourse, which rendered this rather long prefatory explanation indispensable, is to show that the three primary laws of motion, discovered by Galileo, Kepler, and Newton, treated of in *rational mechanics*, are also the three primary laws that govern the molecular motions in the living organism. The mechanical laws referred to are laid down in the following extract from the *Positive Philosophy* of M. Auguste Compte, edited by Miss Martineau, as follows:—*

"Bodies being supposed inert, the general facts, or laws of motion, to which they are subject, are three; all results of observations. The first is that law discovered by Kepler, which is inaptly called the law of inertia. According to it, all motion is rectilinear and uniform; that is, any body impelled by a single force will move in a right line, and with an invariable velocity. The second law we owe to Newton. It is that of the constant equality of action and reaction." "Whether the movement proceeds from impulsion or attraction, is, of course, of no consequence. The third fundamental law of motion, involves the principle of the independence or coexistence of motions, which leads immediately to what is commonly called the composition of force. Galileo is, strictly speaking, the true discoverer of this law."

I proceed now to show that laws similar and identical with the above, are the fundamental laws of vital movements. The essential phenomenon of life is the unceasing activity of molecular motions or actions. Their complete cessation is death. The

* The Positive Philosophy of Auguste Compte, p. 111.

molecular actions of life have definite ends. They accomplish determined objects; and carry out predetermined and calculated results. In these facts, are presented the strongest evidences of the dominance of law, and the existence of special causes or forces. In the organic and molecular actions are demonstrated the laws, by which living organisms are constructed and their functions maintained. Living phenomena are to be interpreted by them.

I lay down as a proposition, that the organic molecular actions have no existence, except in the presence of germs. This is demonstrated in the unfecundated and fecundated egg and seed, as under the same conditions of air and temperature, the one proceeds on to the development of an organized living being, while the other rapidly putrefies. The germ force or law and the organic force or law, are shown by this universal fact to be identical.

The vital or organic molecular actions have for their ultimate end the production of special organizable matter, a development of organic forms and living organisms. As the phenomena of living beings are neither simple nor similar, it is impossible that they can be the products of a single force, or consequences of a single law. The laws that maintain the complex molecular movements of life, are not equally important. Some are primary and fundamental; others are secondary and coadjutant. The former, or fundamental laws, are those to which I now invite attention. They have the closest analogy and correlation with the laws of mechanical motion, precedingly cited.

The first law is, *that the organic molecular movements of the germ, when once commenced under normal conditions, continue in a direct line, through determinate and successive stages of organic forms to the ultimate development of a perfect organism.* Each germ appears to include within it, or to be deeply impressed with the ideal type, which it ultimately realizes in a material form, from a formless fluid. This law of germ-force is as definite and absolute as that of gravity, or any other of the recognized forces. As long as this law experiences no interference by another force, it corresponds to Kepler's law, to wit: that all motion is in a direct line and uniform. The perturbations occasioned in this organic law by exterior or interior disturbing causes, are

proofs of its existence and its purpose. They give rise to deviations in the process of organization and the type of form. In this manner are produced numerous varieties and anomalies of organization and monstrosities. These irregularities, long regarded as inexplicable, have been subjected to scientific arrangement by Geoffroy St. Hilaire, in his classical work: *Traité de Teratologie.* The causes that occasion these disturbances, and the manner in which these irregularities of form and structure are produced, are capable of demonstration. In the above work, and by more recent observations, they have been investigated and explained to a certain extent.

The second law is identical with that discovered by Newton. It is *the equalization of action and reaction.* This is an essential characteristic of the organic molecular actions. In the living organism two series or classes of actions and reactions exist; the one internal, the other external. The first is that which occurs between the fluids and solids, or between the liquid plasmata, the elements of organization and the organized structure, evolved from them. Nutrition, which forms the essential action of life, consists in this mode of action and reaction. The fluid organizable plasmata are changed into solids, and the solids re-enter in new forms and states, into the fluids. The organic matter of the solids is wasted or destroyed in the functional actions of the organs, and is replaced by fresh supplies derived from the blood. This change of matter is slow in the tissues of low vitality, as in the mechanical tissues, cartilage, bone, ligament, etc. It is rapid in the highly vitalized tissues and organs, performing the active offices of life, such as muscles, mucous and glandular epithelia, nervous ganglions, etc. The equalization of action and reaction in living organisms is not capable of the perfect adjustment of that which prevails in mechanics. It is relative, and variations within certain limits are not incompatible with vital actions more or less imperfect. In the earlier stages of development, such as the embryonic, the fœtal, and the period of growth, nutritive formation preponderates over deformation. After development is completed, the equalization of these processes may remain, frequently for years, accurately balanced. The daily ingesta, though large, are exactly counterpoised by the egesta, so that no increase of weight results. The disturbances of this law, producing devia-

tions from its normal limits, are the most common causes of pathological conditions. The various hypertrophies of organs are obvious results of excessive formative nutritive action; and atrophies, it is equally clear, arise from the opposite excess of deformation.

In the normal state a due apportionment of fluids and solids exists in each structure, regulated by its degree of vital and functional activity; or, in more definite terms, in the mode and degrée of their molecular actions and reactions. The fluids are in a certain excess in structures of highest vital endowments; the solids in those that are lowest in the scale. This regulated equalization in the organic molecular actions and reactions of each particular tissue and organ, and the adjustment of the fluid and solid parts of each, adapted to its vital and functional processes, are the normal or healthy state of the organism, in which its anatomical arrangements are perfect.

The fluid is as indispensable an anatomical element of structure as the solid, and its deviation in proportionate quantity or alteration in quality, is as much an anatomical lesion as any change in the solid elements. This important pathological fact has been almost wholly overlooked in the researches of the pathological anatomists of the Paris and Vienna schools. The alterations of the solids, demonstrated by the scalpel and microscope, exhibit only one side of the phenomena. They present a limited and imperfect view of the true pathological facts, always complicated, always compounds of different and diversified elements.

The abnormal organization of the solids, the effect of disease, is similar to the normal, inasmuch as it is also a result of the organic molecular actions and reactions between the fluid plastic matter of the blood and the solids. When these actions and reactions are normal, there can be no deviation from the type of the organic model: the organizations must be normal. This law of the equalization of organic action and reaction is liable to be influenced by, and subject to, numerous disturbing causes, vitiating the products of the functions and processes of the organism. Many of these originate in the organism itself; such are mental, moral, and nervous influences. Others proceed from exterior causes, such as variations of temperature and other atmospheric, possibly some planetary influences. Vitiation of the atmosphere

by numerous morbific agents and poisons, infecting the blood and rendering it unfit for the normal actions and reactions of life; deficiency of the due quantity, or defects in the nutritive quality of the liquid and solid aliments for the formation of blood in appropriate quantity and composition; and external disabling injuries are some of the instances of this character.

Perturbations, variations, modifications of the above organic law of equilibrium of action and reaction lie at the root of most all acute and chronic diseases, involving organic lesions, whatever may be their nature. It is seen in sanguine and lymphatic irritations, in congestions, inflammations, the diseases classed as fevers, though wholly dissimilar.

Equalization of the actions and reactions of the spinal and muscular forces exists in health: and when disturbed, various neuroses or nervous diseases are the consequence. The same law of balance prevails also in the different cerebral functions, where its disturbance causes various psychological disorders.

The second class of actions and reactions are those that are external. They take place between a living organism and the surrounding media, necessary to its existence. These are heat, air, or oxygen, aliment and water. They are absorbed in certain nearly definite quantities by exterior and interior surfaces, such as the skin, lungs, and alimentary canal. Corresponding quantities of heat, carbonic acid, water, and various excreted matters are eliminated from the same surfaces. Health and life are dependent upon the equalization of these actions and reactions. The facts relating to this particular class are so familiar to almost every one, that an especial demonstration may be dispensed with.

The third law is perfectly homologous to that of Galileo, and may be stated in the same terms, namely: *the independence or coexistence of motions.* In the molecular actions, or movements of organic bodies, the kind of movements are dissimilar, yet each kind is independent, though coexisting and operating in harmony with the others to a single end.

The organic, or vegetative functions, offer evidences of this third law. It is now admitted that they are chemical, physical, and mechanical. In digestion, the alimentary substances are subjected to various chemical transformations. Starch and sugar,

for instance, are converted into glucose, and this into lactic acid and lactates; the albuminous matters are changed into albuminose. The hydro-carbons and carbo-hydrates of the food and drinks, undergo various and numerous processes of oxidation, slowly and imperceptibly evolving heat, and exciting new chemical molecular actions. The peptone albuminose, the product of gastric digestion of albuminoid substances, is reconverted into albumen of the blood, and this again is metamorphosed into the immediate organizable plasmata, of which the tissues are formed, while the tissues themselves are decomposed into the various excretions eliminated from the economy. All these changes are seen to consist in a series of independent chemical processes, throughout which prevails the equalization of action and reaction.

Physical actions are not less numerous than chemical, and are equally indispensable to organic life. Capillarity, endosmose and exosmose, are properties of all organic tissues. By their agency, absorption of exterior matters into the blood, and interchange of the oxygen of the air, and carbonic acid of the blood in respiration are accomplished. The plasm or lymph of the blood is transfused by exosmose from the capillaries into the tissues for their nutrition. The excess is carried off, and prevented from inundating the organs, by endosmose, in one direction into the venous radical retes, and in another into the lymphatic radical retes. In this process is developed a physical force equal nearly to an atmospheric pressure, fully adequate to carry on the lymphatic circulation, and to lend additional force to the venous circulation.

Sight, hearing, and phonation, or voice, are purely physical phenomena, and cannot be treated of, or understood, independently of physics.

Electric actions are excited into activity by the molecular actions of the animal organism, which is a constant generator of electricity. The organism, in its electrical relations, is again brought within the circle of the physical sciences.

The most important functions of life are directly sustained by mechanical actions. No part of physiology has been so much neglected, though in no other has medicine, as a practical art, a deeper interest, than in animal mechanics. The function of respiration is maintained, in all breathing animals, by the me-

chanical actions of the chest, while the other actions concerned in the process are purely physical. The circulation of the blood is sustained by the mechanical actions of the heart. And the whole apparatus in the higher animals is the most perfect hydraulic mechanism that can be conceived of.

Muscular tissues are the mechanical instruments of life. The mechanical force, exciting them into action, is a composition of forces, a resultant of the nervous motor-force of the anterior centres of the spinal marrow and the contractility of the muscular fibres. These forces, together with the nervous and muscular organic substances, are wasted and consumed by muscular action, while they are renewed and renovated by repose. One-third of the time of life is required to keep the mechanical and dynamic apparatus in perfect working condition for the longest period; less time than that shortens life, causing premature decay.

A last class of dynamical actions are those displayed in the phenomena of the nervous system. They are the excito-motor actions of the cerebro spinal system, governing the automatic functions of the economy, the special sensibilities, each presenting its kind of actions, and the psychological actions of the intellectual faculties connected with the brain.

In this brief summary are shown the numerous and diversified actions co-existing independently in the organism of man and the higher animals. In the normal state they co-operate in unison and perfect harmony, and enable the individual to perform with ease and facility, the various duties assigned to him in existence. This law, like the preceding laws, is, however, liable to perturbations, modifications, variations in degree, and other pathological states. Each particular kind of action may be separately deranged, though generally there is a complication of several disorders originally, or else it is speedily induced. Thus, some affections are characterized by disordered chemical action, as in diabetes, vitiated secretions, certain digestive derangements, uric and gouty diatheses, production of abnormal matters, abnormal growths, and permanent lowering of the normal temperature.

The physical actions are disordered in suspension of endosmose, excess of exosmose, effusions into cavities and areolar tissues, imperfections of the optical, acoustic, and vocal apparatuses, and in other analogous cases.

Mechanical actions are deranged and become pathological in valvular alterations of the heart, the enlargement of that organ, and the hypertrophy and atrophy of its walls. They are also disordered in hernias and other displacements, strangulations, strictures, fractures, dislocations, and similar casualties, forming a class of mechanical diseases.

The dynamical actions also are frequently subject to various perturbations. These are shown in spasms, convulsions, irregular muscular movements, palsies, morbid sensibility, neuralgias, hallucination of the senses, and in moral and mental insanities. Diseases regarded in this manner may be classified as organic or constitutional, chemical, physical, mechanical, dynamical, and psychological.

The applicability to the living organism of the three primary and general laws, previously stated, and long since adopted in mechanics, dynamics, statics, astronomy, etc.; and the correlations existing between the fundamental principles of these positive sciences and those of medicine, which I have in the foregoing observations attempted to demonstrate, appear to me neither as fanciful hypotheses, nor deductions by forced interpretations. This indication of the similarity between the above primary and general laws of mechanics and those which govern the living organism, or in fact their identity, is the logical consequence of a correct analysis of the complicated phenomena of life, as manifested in every possible state of health or disease. The recognition of these facts is the legitimate result of thirty years of theoretical study and practical experience.

All forces act on the molecules of bodies, but in mechanical motion a single force acts on each molecule in the same direction and with the same intensity. Consequently, there is produced a single phenomenon or movement of the whole mass in rectilinear direction. The vital organic molecular movements, however, are excited by different forces. The molecules being acted on conjunctively by several separate forces in different modes and different directions, complex phenomena, changes of form, and of properties, without motion in space ensue.

The three primary organic laws, simultaneously active or cooperative, produce a composition of forces, of which the resultant is, what has been termed the organic or vital force or principle.

The organic or life-action, the primary and necessary result of this composition of forces, is shown by analysis to be itself a complex phenomenon, corresponding to the above laws, and demonstrative of their co-operation. This phenomenon consists, first: in the simultaneous production by chemical actions of special organizable materials; second: the assumption by those materials of organic forms, peculiar to each genus and species of structure; and third: the decomposition of the organized matter or transformation into lower chemical combinations, causing a continuous change or waste of the organic matters of the tissues, without the slightest change of their organization. These complicated independent molecular actions, in which the equilibrium is so perfectly maintained, as to preserve the type of structure, the organic form wholly unimpaired, presents strikingly the characteristic difference between the organic and inorganic world, or organic and inorganic bodies, inasmuch as all molecular movements of the latter involve a change of form.

The primary organic laws or forces, resulting in, and acting as a single law or force, are manifested in the first stages of organized development, as formative; in the completed or adult period, as reparative and conservative; in old age, as the order of decline, or natural decay and death. This compound law or force resists, to a certain extent, exterior and interior disturbing causes; excites defensive and therapeutical processes for their removal or destruction, tending to effect a subsequent restoration of the organism to its normal state: it is then recuperative. It is the true physician of nature, recognized from the earliest epoch by the great observers and profound thinkers of the medical profession, as the "Vis conservatrix et medicatrix naturæ."

A complete knowledge of the primary organic laws and their perturbations, causing disturbances in the animal organism, is indispensable to determine its pathological states or diseases. Such are the requirements of medicine as a philosophical science. The cultivation of physiology in the spirit indicated above, and based on physical laws, is destined to assign to it a place in the circle of the positive sciences; and in its inseparable conjunction with medicine, the latter will constitute one of the highest and most developed departments of human knowledge.

The laws that have been indicated to you do not possess spon-

taneous action. They are conditioned, and manifest themselves only as regulating molecular activity, productive of organic forms. The conditions of their action are, first: the presence of germ-force, on which depend the formative molecular movements, characterized by modality, or the production of special organic forms and structures; second: caloric of definite temperature; third: organizable or plastic matter; fourth: atmospheric air; fifth: water.

In this discourse I have presented to you the manner in which "I think my thoughts," and I have shown to you the stand-point from which will be regarded all the varied phenomena and subjects that will come under consideration and critical review in this course of medical instruction. The method to be followed will rest on the solid and substantial basis of positive philosophy, and the facts we shall have to observe will be treated as subjects of the positive sciences. The facts of medicine are complex, and science, demanding the co-ordination of facts for the deduction of the general laws which govern them, these facts must first be proved and thoroughly known before their laws can be discovered and science established. The importance of this simple truth, not having been sufficiently recognized hitherto, is the cause of the defective condition of physiology and medicine. "The backward state of physiological science," remarks the profoundly philosophic Compte, "is owing mainly to the vicious training of physiologists, and the irrational institution of their habitual labors. What can come of a study of complicated phenomena, if the student have not learned, by the contemplation of the simpler, what a law is; what it is to observe; what a positive conception is; and even what a chain of reasoning is? Yet this is the way our physiologists proceed every day, plunging into the study of living bodies, without any other preparation than a knowledge of a dead language or two, or at most, a superficial acquaintance with physics and chemistry, acquired without any philosophical method, or reference to any true point of departure in natural philosophy."

I will trespass on your patience for a few moments to quote some further remarks of this high authority. "The progress of physiology depends on the growth of positive elementary conceptions, and the natural development of the science has furnished

means for its complete institution to be begun. This I look upon as the proper task of the existing generation of scientific men, who need only a better training to make them adequate to it. If, from its complexity, physiology has been later than other sciences in its rational formation, it may reach its maturity more rapidly from the ground having been cleared by the pursuit of the anterior sciences. Many delays were occasioned in their case by transitory phases, which were not understood in the earlier days of positivity, and which need never again arrest experienced investigation. It may be hoped that physiologists will spare the science the useless and humbling delay in the region of metaphysical hypothesis, which long embarrassed the progress of physics."

When, last summer, I became acquainted with Mr. Compte's admirable work, it was a source of encouragement to me to find the method of investigation, upon which I had ventured some twenty years ago, and had persisted in it, under disadvantageous circumstances, and much unfavorable criticism, was similar to the one advocated by that philosopher. It would afford me the highest gratification should I be able to indoctrinate you with the views and principles here advanced, so that after issuing from this school you may become known and recognized as scientific practitioners—the true interpreters of the laws and states of man's organism in health and disease, and the exponents of *Positive Philosophy in Medicine.*