An introductory lecture, preliminary to a course on the institutes of medicine : delivered on the 9th of October, 1850, before the medical class of the University of Pennsylvania / by Samuel Jackson.

29

AN

INTRODUCTORY LECTURE,

PRELIMINARY TO

A COURSE

ON THE

INSTITUTES OF MEDICINE,

DELIVERED

On the 9th of October, 1850,

BEFORE THE MEDICAL CLASS OF THE UNIVERSITY OF PENNSYLVANIA.

BY

SAMUEL JACKSON, M. D.,

PROFESSOR OF THE INSTITUTES OF MEDICINE.

Published by the Class.

PHILADELPHIA:

JOURNEYMEN PRINTERS' OFFICE,

No. 5 Harmony Court.

1850.

CORRESPONDENCE.

UNIVERSITY OF PENNSYLVANIA,
Oct. 19th, 1850.

PROFESSOR JACKSON:

DEAR SIR—At a meeting of the Medical Class of the University of Pennsylvania, the undersigned were appointed a Committee to request for publication a copy of your truly able and eloquent Introductory Address, delivered October 9th, 1850.

Hoping that you will comply with their request, we are, sir, with sentiments of high regard, Very respectfully yours,

JOHN H. DECHERD, Tennessee,
ANDREW R. BARBEE, Jr., Virginia,
WALTER BRICE, South Carolina,
JAMES H. TURNER, Virginia,
JAMES P. BURKE, Tennessee,
Committee.

Phila., Oct. 19th, 1850.

GENTLEMEN—Your note of this date, requesting a copy of my Introductory Address, was receive this evening.

I cannot refuse to comply with the wishes of the highly respectable body of students composing the Medical Class of the University. A copy will, therefore, be placed at your disposal. Accept the assurances of my respect,

And believe me truly yours, &c.,
SAMUEL JACKSON.

To Messrs. John H. Decherd, Tennessee, Andrew R. Barbee, Jr., Virginia, Walter Brice, South Carolina, James H. Turner, Virginia, James P. Burke, Tennessee, *Committee.*

INTRODUCTORY LECTURE.

GENTLEMEN MEDICAL STUDENTS:

I salute you and welcome you to this ancient seat of medical science and instruction.

The University from its foundation has been devoted to the maintaining of the honor and dignity of the profession, to the cultivation of medicine as a science, to the expansion and perfecting of its instruction, keeping pace with advancing knowledge.

The Faculty feel the responsibility that rests on them, and will omit no endeavor to hold up the well-earned renown of the school. The instruction of the courses will be kept on a level with the progress of the times; sound principles and correct practice will be enforced, and a high professional tone be infused in the students as the best safeguard against the debasing influences of the age.

The object you propose to yourselves in coming to this city is laudable; the motives that govern your selection of medicine as a profession are noble. You would be physicians—men-healers—men-savers. It is in the order of Providence that all that live must suffer and die. None are exempt from this universal law. The lowest animals and plants are subjects of disease as well as man, and are surrounded with endless causes of destruction. The epidemic that of late years has affected so extensively one of our best esculent plants, and appears to threaten its extermination, is a striking evidence of this law. While suffering, disease, and death are knitted with the life-yarn of man into his existence, yet is there much of each wholly avoidable, that is not of necessity in his nature, which may be prevented, and from which he may be saved.

If men knew and would live in conformity to the law of their existence, if they would keep a harmony between the outer circumstances of their life and its inner conditions, there would be brought about a great diminution of disease and of the number of deaths.

God in his great mercy, while he has created man subject to so many infirmities of body, and liable to so large an amount of disease, and exposed to so great mortality, has, at the same time, appointed modes or ways by which diseases are cured by the operations of his own economy; by crises, as they are called; by a time-limit fixed for disease, beyond which it cannot go, but must end; and by the possession of special properties in medicinal substances, by which they can set up in the living organism of man, the natural curative actions or crises by which diseases are carried off.

This knowledge, which covers an immense field and involves a great amount of researches, constitutes the science and practice of medicine. It must form, in the organization of society, the pursuit of an exclusive profession, devoted to the investigation of man's exterior and interior life, in all their various modes, states, conditions, and phases of existence. The range of studies embraced in the medical profession is the whole of the physiological sciences, those especially that have relation immediately to the physical, vital, and moral nature of man, in health and in disease.

I propose, as the subject of this discourse, to show to you that medicine is a science and not a mere art; a combination of scientific and philosophical laws, and not a system of empiric rules; that it cannot be practised by the ignorant without danger, and requires for its exercise extensive knowledge, intelligence, and judgment.

There are, philosophically speaking, no accidents, no chance in nature. *Throughout her vast domains the supremacy of law prevails; harmony and order reign.* No operation, no phenomenon occurs, however insignificant, that has not been provided for; that is not the result of a pre-existing law. It may be said, in this sense, it *was pre-ordained.* General and special laws, sustained and adjusted in their operations by the superintending power of Omnipotence, are His agents in the government of the universe. Every step in the progress of knowledge that opens clear views of natural phenomena, and every development of scientific facts in their various relations, demonstrate the truth of this proposition. The sciences to which the term exact is applied, afford the most apt and happy illustration. In astronomy phenomena are determined with the utmost precision, to the smallest fractions of time. This may be done not only for the present, but may be carried far into the past, or be extended into the infinity of the future. The astronomer can calculate what was the position of any planet at a particular moment in the earliest days of time; he can determine in what precise point it will be some hundreds of years hence. Eclipses of planets and occultations of stars can be designated with equal accuracy as having taken, or that will take, place in remote eras, past or future. The affirmations of astronomers as to the history of the heavens in past ages, and their predictions of what it will be in time to come, have no other limits than the powers of the human mind in calculating.

The certainty of astronomical science arises from the simpleness of its facts, and the unity of its laws;—the one consisting of the movements of the great masses of matter forming the heavenly bodies, and the other, the Newtonian law, the cause of those movements.

Chemical science, though far more complicated in its phenomena and laws, falls very little short of astronomy in the accuracy of its processes and its calculations. The chemist performs his experiment with almost unerring certainty. He knows positively what results will occur by bringing together different chemical substances. He can give the exact compo-

nents of a mineral substance from its crystalline form, found in any part of the world. The chemical arts are practised by persons entirely ignorant of chemical science. They follow rules and formulæ, by observing which they make various chemical preparations, or obtain a particular dye or shade of color, although ignorant of the laws by which they are produced, and of the principles by which the results are explained.

Chemistry, by its researches, has penetrated to the molecules of matter. It weighs them, ascertains their numbers in any body, studies their properties, affinities, and other relations. These are so accurately ascertained, that they are arranged into tables for reference. Chemistry, in modern times, rivals Mathematics and Geometry in the exactness of its calculations and the precision of its formulæ.

It would occupy too much time to review all the physical sciences,—Optics, Acoustics, Thermotics, Electricity, Magnetism, and others,—for additional evidence. A superficial acquaintance with those branches is sufficient to confirm the correctness of the theorem. In each, the phenomena have been studied thoroughly, and ascertained in all their conditions. In each, the general laws or principles governing the phenomena have been accurately defined. Theoretically and practically, in science and art, they are perfect and positive.

A knowledge of the laws of light has enabled opticians to construct instruments by which human vision has been able to fathom the distances of infinite space, and discover the existence of myriads of unknown worlds,—while in another direction, by other instruments, we have penetrated to the not less wonderful region of the infinitely small, and have laid open to us a new world of organic beings, and have displayed before us the molecular region of organic life.

The complete knowledge possessed of the nature of sound and its laws, has perfected music as a science and an art, the most powerful agent in subduing the ferocity of the passions, in cultivating the softer feelings that harmonize the soul, and win it from the grossness of low pursuits and debasing dissipations.

> "The man that hath not music in his soul,
> Nor is not moved by concord of sweet sounds,
> Is fit for treason, stratagems, and spoils;
> The motions of his spirit are dull as night,
> And his affections dark as Erebus;
> Let no such man be trusted."

The steam engine, brought to its present high state of improvement, is a result of the knowledge of the laws of heat. There is acquired by the application of the force generated through this invention, a power equal to unlimited numbers of men or horses, or equivalent to an indefinite augmentation of population, without the expense of land, houses, or food. The steam engine is the most important element of national power and great-

ness; it is the most potent arm man has devised to aid him in subduing nature to his purposes.

The accidents, as they are called, so often occurring from them are entirely avoidable. They are the consequences of reckless neglect, or ignorance of the laws of heat as applied to the instrument.

The wonder of the present day, the electric telegraph, is another illustration of the practical results flowing from the certainty that exists in our knowledge of natural phenomena and their laws. The molecular force, electricity, existing in the electric battery of a storm-cloud discharged on the earth, is displayed in destructive power. Controlled and directed by the telegraph, thought acquires wings, and language outstrips time. It is not restricted by space; those separated by hundreds, even thousands of miles, hold converse; mind, intelligence, knowledge, are become ubiquitous.

The sciences termed exact acquire this designation from admitting the application of calculation to all their phenomena. The facts of each belong to a single series, and are capable of being arranged in formulæ. There is little or no complication to confuse observation, and embarrass induction. The investigation being limited to one direction, does not demand an extensive range of knowledge. They can be mastered by application, industry, tact in observation, fertility in devising experiments, and a clear judgment in arriving at conclusions.

The physiological or medical and the moral sciences have no such character. The phenomena are complicated, not one is simple and single. They present different phases: seen in one aspect alone, they cannot be understood. Whoever investigates and would explain them must be able to go round them and read each face separately.

Nor is there a single law or condition under which their phenomena are produced. The special laws that concur to the production of each phenomenon are as numerous as the number of faces it exhibits; and consequently to be able to recognise the special law and special aspect of a phenomenon, will require a knowledge of the branch to which it belongs. Without this extent of knowledge, which will enable the observer to look at the whole phenomenon in each of its aspects, it cannot be analyzed and its separate elements determined. Until this be done, it cannot be truly interpreted, nor can there be real progress in knowledge.

Viewed superficially, the phenomena of the Physiological and Medical sciences appear unstable, confused, complex, and obscure, exposed to a thousand chances and subject to endless accidents. They appear to form a labyrinth, without a clue by which its intricacies might be threaded.

But when studied with care and more thoroughly comprehended, evidences of subordination to law, of order, of connexion, and of design, become clearly manifest.

Observations confined to small numbers of individuals or facts, are of

no value in determining general principles. Individuals are so differently constituted from each other, that no consistency of details can be perceived amongst a few, or the evidences of positive law plainly discerned. It is totally different when masses are brought under observation. Individual discrepancies then disappear, and the general concordance of the phenomena demonstrates the existence of law which has produced them.

From the limits of this discourse, I must confine myself to indicate merely, in Physiology and Medicine, the evidences that prove conclusively the existence of order and laws, as well established as in the positive sciences.

The investigations carried on for some years past in ovology and embryology are most pertinent to this point. The period of development of the egg or the embryon may be determined almost to the hour by an experienced observer, so fixed and regular is the succession of the stages of organization. The law of organic development is a general law, for the phenomena are mainly the same in all animals, and for all tissues and organs.

This fact is demonstrable in the researches of histology and morphology, or the study of the origin, development, and forms of the tissues and organs of animals and vegetables. They are constituted from a common crude plasma, albumen for animal, dextrin for vegetable tissues. They commence in common forms, granules, cells, fibres. The same series of primary forms mark the first stage of development of both animal and vegetable tissues. The differences of organic material produce the differences of the subsequent forms, for the form is the necessary and indissoluble result of the material.

Vital statistics furnish the most unimpeachable evidences of the existence and action of laws in determining the phenomena of living beings. Investigations show that in every country there is a nearly fixed ratio of births to population, and more boys are born than girls.

The following tables prove these results:

Annual births to 100 *persons living.*

France	.	.	2.837, or 35 persons living to one birth.		
England	.	.	3.208, or 31	"	"
Prussia	.	.	3.767, or 27	"	"
Austria	.	.	3.874, or 26 persons living to one birth.		
Russia	.	.	4.284, or 23	"	"
Philadelphia from 1820 to 1840			22	"	"

The number of boys born to 100 girls, is in the following ratio:

The lowest is Sweden	-	-	-	104.62
Russia, the highest	-	-	-	108.91
Philadelphia	-	-	-	107
The Western States said to be	-	-	-	110
The mean of all Europe is	-	-	-	106

The same relation appears in the still-born.

In cities the ratio of still-born to births is 1 to 20.

For the country 1 to 38.

The greatest mortality of the still-born is amongst boys in the proportion,

For Berlin 28 boys to 20 girls.

The same for Flanders.

For Amsterdam 13 boys to 10 girls.

A law of mortality determining the number of deaths in any given number of a population, at each age of life, is ascertained to exist by the same extensive researches. One-tenth of the children born die in the first month; twenty-five per cent. have disappeared by the fifth year, and one-half only are alive at twenty-five years.* In England the annual morality to the population is

Per cent. 2.160, or	1	death	to every	46	living	persons.
In the North of Europe	1	"	"	41.1	"	"
Centre of Europe	1	"	"	40.8	"	"
South of Europe	1	"	"	33.7	"	"
Philadelphia	1	"	"	48	of all colors.	
"	1	"	"	51	whites.	

From the tables constructed by the Registrar-General, from the returns of deaths made from every parish in England, amounting annually to about 394,000 deaths, there appears in the ordinary diseases, excluding epidemics and zimotic diseases, a nearly invariable proportion of deaths, not varying more than $\frac{1}{20}$ to $\frac{1}{4}$ per cent. This statement is verified by the following tables.

Deaths from Pneumonia, to 1,000,000 *living.*

Years 1838	1839	1840	1841
1.219	1.200	1.209	1.154

From Phthisis.

3.996	3.939	3.897	3.822

From other diseases of the respiratory organs, there died in the

	Years 1838	1839	1840	1841
	.934	.850	.937	.935
From diseases of urinary organs	.112	.101	.110	.106
Deaths from hernia	.507	.474	.480	.475

The above is sufficient to establish the principle which is borne out by all the details of vital statistics.

Facts of a similar character, collected by the statisticians of Europe, indicate that man's physical and moral nature, in which he is to outward appearance wholly free to act as he may choose, is controlled in its operations by general laws, determining in every community the actions of individuals. These may be tabulated, as to number and nature, for any given number of individuals, for the periods of life, the seasons and climates in which they are most common.

* Registrar a Quetelit au l'Homme, vol. i., p. 176.

Physiology furnishes the most decisive evidence of established laws directing the functions or offices of life. Any one function might be selected as affording apt illustration on this point; a few will be selected from the function of respiration.

The object of respiration is to convey oxygen into the blood and free it from carbonic acid. In lung-breathing animals, this is accomplished by an automatic or self-acting apparatus. It is controlled to a certain extent and for special objects, by the will, but is independent of that faculty for its action.

The pneumogastric and spinal nerves, with the respiratory ganglia of the medulla oblongata, are the dynamic portion of the machinery. The special sensibility or force residing in them, excited by the presence of black blood and carbonic acid gas in the lungs, rouses into action the diaphragm and intercostal muscles, mechanical instruments, which expand and enlarge the chest. The physical law of atmospheric pressure comes into play, and forces the air through the air-passages, the nostrils, trachea, and bronchi into the lungs. When the air has arrived in the lungs, the physical law of endosmose and exosmose, with Graham's law of the diffusion of gases cause the oxygen of the air to enter the blood, and the carbonic acid to pass out. A larger proportion of oxygen is introduced than of carbonic acid that escapes. This is often in the proportion of Graham's law, 1000 oxygen to 1174 carbonic acid.

This function, it is thus seen, is a combination of dynamic, mechanical, and physical phenomena, and is accomplished by a combination of dynamic, mechanic, and physical laws. It is self-regulating, and varies, as to the number of respirations in a minute, according to various individual conditions. The mean in male adults in health may be taken at twenty inspirations in a minute, and the average volume of each inspiration at 16 cubic inches. The quantity of air passing through the lungs in twenty-four hours may then be estimated at 460,800 cubic inches, or 366.66 cubic feet. Many physiologists have endeavored to ascertain the quantity of air that could be taken into and expelled from the lungs by a forced inspiration and respiration. No two obtained corresponding results. These discrepancies have been explained by a law ascertained by the numerous and elaborate researches of Mr. Hutchinson on respiration. This law, founded on nearly 2000 cases, and confirmed by 4000 additional cases, is the following:—

"That for every inch of stature from five to six feet, eight additional cubic inches of air at 60° are given out by a forced expiration." This rule was unknown by former experimenters, and the neglect of it led them to erroneous inferences. The rule is so positive, that the quantity of air a male adult should breathe, in health, can be determined by his height every diminution of that quantity is an indication of disease. The spirometer, or instrument for measuring respiration, is one of the most delicate diagnostic means for ascertaining the incipient stage of pulmonary affection.

I must limit myself to the above facts, a portion only of what may be called the pneumatics of respiration. My object is to prove the existence of positive laws in the functions of the animal economy, and they are clear on that point.

In therapeutics, facts are ascertained that show a special relation between the properties of medicinal substances and particular organs or apparatus of the animal economy, through which the vital state of the organs and the operations of their functions are modified. Instructed physicians, who are acquainted with these relations, by the agency of medicines, regimen, and other remedies, change and influence in various modes, according to the indications of the case, the organs the subject of disease, remove, through the functional actions they excite, the impediments that obstruct the natural recuperative processes by which diseases are cured, and bringing them into play, effect the recovery of the patient.

These relations are so regular, that medicines are arranged, in the materia medica, in particular classes, designated by names expressive of the influences they exert on the whole economy, or on certain organs and functions, as sedatives, stimulants, emetics, purgatives, &c. The articles of these classes are prescribed with a strong assurance that, if judiciously selected and administered, the effects expressed in the name will be realized.

These relations between the properties of medicinal substances and the organism of man, are one of the most beautiful harmonies existing in nature, and display in a strong light the watchful oversight and the unending goodness of Providence in the government of our world.

The facts of pathology are not less impressive. We possess authentic histories of diseases, in the works of the highest authorities, from the earliest epochs of our science. It is a remarkable trait in the literature of medicine, that it appears to have had no period of infancy. It breaks upon us in the fullness of maturity and manly vigor, rich in truthfulness of observation, profoundness of thought, and depth of philosophy.

Commencing with the works of Hippocrates, which, as models of observation, are unsurpassed, and continue to be high authority in our day, we possess those of Galen, Celsus, Aretæus Paulus Egineta, followed by the Arabian writers; they are succeeded by the restorers of medicine in the middle ages, Frascatorius, Forestus, Riverius, Fernelius, Sennertus, Mercurialis, Diemerbrœck, to the period of Sydenham, Baglivi, Boerhaave, Hoffman, and the modern era. We have thus a connected series nearly unbroken of medicinal observation and descriptions of diseases for 2200 years.

In this manner we possess authentic testimony that during this long lapse of time, the human organism has been subject to the same diseases, endemic, epidemic, and sporadic; fevers, inflammations, and other affections, occurring at the same seasons and under the same circumstances, as at this day. Laying aside the hypothetical explanations of the causes and

nature of disease and the operation of remedies, drawn from the imperfect science of the age, we find the writers of the earliest era of our science accurate authorities for facts such as we observe them in our daily practice.

In this persistence and constant recurrence of the same morbid phenomena in the animal economy, it is impossible not to recognise the operation of fixed laws that develop, control, and determine them.

From the foregoing observations it must be concluded, that in physiological or medical sciences, the phenomena are inevitable results determined by laws; that they are no more accidents than are the phenomena of the exact sciences; that they are the subjects of rigorous observation and experiments, capable of calculation, analysis, and classification; that they may be foreseen, predicted, regulated, and prevented, by knowing the laws which rule them. In other words, that medicine is to be classed with the exact sciences, that it is to be taught and cultivated and practised in the spirit and on the plan of a positive science, and not a conjectural or empiric art; and when developed in its strength and grandeur, it will become the highest department of philosophy.

Where laws exist generalization is possible and is indispensable; and where several laws combine in the production of compound phenomena or complex actions, there must be some one radical or primary law or generalization, around which the others are grouped, and which determines their action. This radical law must lie at the root of all the phenomena, and run through the whole of the science. Its discovery is most important in forwarding the breaking up of compound phenomena, the clearing away of their obscurities, and the perfecting of science, by rendering its apparent complexities simple and plain.

Numerous attempts have been made to establish in physiology and medicine a generalization that would embrace and give unity to the science.

They proved failures: investigations and means of research had not then delved, as now, deep into the interior regions and the minute structure, and unseen actions of organization, so as to enable even the most vigorous and gifted intellects of that period to obtain a view of all the varied facts, and clutch them in a single grasp.

The progress of knowledge, by making clear and distinct what was dim and hidden, enables very inferior minds to understand, at this time, what was before incomprehensible to the greatest philosophers.

In living beings there exists a series of fundamental organic phenomena, observing a most perfect uniformity. It consists in the production of organic plasmata or materials for organization; of primary and secondary special organic forms; and the arrangement and adjustment of these dissimilar pieces, in a manner to construct organs or life-instruments, some simple, others complex, some physical, some chemical, some mechanical, fitted to perform offices of various kinds for the use, conservation, and existence of the individual.

There is no exception in the organized and living being to these general phenomena, as the basis of their existence. They belong to vegetables and to animals; to the formation of the simplest cell, of the most compound tissue, and most complicated organ. They cannot be separated from organization and from life.

Those phenomena, always definite, must be produced by equally definite actions; they are life actions. These life actions, observing a regular and uniform course, must be directed by a special law; it is an organic or life law. Now these life or organic actions, and this life and organic law, are not manifested except under the acting of a force,—it is an organic or life-force.

The foregoing fundamental phenomena of organized and living beings and structures do not occur indiscriminately and indefinitely. They can exist only under certain conditions, any of which being withdrawn, they immediately cease; and any perturbation, or change in any one, deranges and modifies, to a corresponding extent, the state of the whole.

These conditions are:—1st. The presence of a germ endowed with organic or life force. 2d. A fluid organizable plasma in its natural state. 3d. Heat of a definite temperature, 98° to 100° for warm-blooded animals. 4th. Pure atmospheric air.

The above conditions are embraced in and constitute the organic or life law.

While these conditions exist in their normal state, no disturbance or derangement of organic or life-actions can take place; there can be no disease involving the structure or organic condition of the organs. Other disturbances may occur, depending on the dynamic nerve, or animal force belonging to the nervous system, which will be shortly alluded to. Constitutional and hereditary diseases, fevers, inflammations, all diseases depending on vices of the blood, chronic, structural and aplastic affections, are to be traced to errors or defects in some one or more of the above conditions of the law of life-actions.

This law, from its active agency, must be extensively applicable to Hygiene, and enter largely into Pathology.

A few remarks on each of the above conditions will show the correctness of the proposition.

1st. Of the germ. It is an organic form, endowed with organic force. Its presence and activity are indispensable to organization. There are two kinds of germs. The ovo-germ, existing in the egg, and nuclei, nutritive centres or tissue germs, belonging to the tissues. The rudiment of the germ, is the germinal vesicle formed in the egg before it has left the ovary. It is the contribution of the mother. When the seminal or male element has combined with the germinal vesicle it disappears, and the germ, the product of two sexes, is formed. The properties of this minute speck, indiscernible by the unaided sight, are the most extraordinary and mysterious

that exist in nature. It forms the connecting link between parents and their offspring, between one generation and another. It is, consequently, the only possible medium that can transmit the characters of the genus and species,—or convey the constitutional peculiarities, temperaments, mental, moral, and physical attributes, and the diseases of the parents, to the progeny.

On the germ depend the order and harmony of the forms of the organic world. This body is microscopic; matter almost disappears; yet there resides in, or is connected with it, the power to impart a special direction to chemical actions for the production of special protoplasmata; it possesses the power to excite special organic actions, developing special organic forms; it is endowed with modality, or the power to cause every tissue, organ, and being to be constructed after a model or type of the genus and species of its class and order, and to transmit parental peculiarities.

Tissue-germs, nuclei, nutritive centres, are the descendants of the ovo-germ, which, by a process of division in the material of the egg, organizes it into nuclei or tissue-germs, and imparts to them the attributes of the organic forces.

2d. The fluid organizable plasma. For the first periods of the development of the embryon, the organizable plasma is furnished by the mother, either laid up in the egg, or obtained through the medium of a placenta. The quality and quantity of the material must, therefore, depend on the organic fluids, and the plasma of the mother. If they be deficient, from poor and insufficient aliment, or deranged functions,—or they are defective, from original or acquired vices, or from disease,—the organization of the progeny will be tainted, or prove defective, and not reach the development of a perfect type.

The plasma being derived from the aliment, and its perfection depending on the digestive functions and the excretions, it is liable, from errors and imperfections in those functions, and deficiency or defective quality of food, to be vitiated and unfitted, or inefficient for the reparation of the organism.

The plasma may also be affected in various ways by the absorption and introduction into the circulation of different substances, poisons, viruses, contagions, and medicines, by which it will be affected in a greater or less degree. Diseases often originate in this mode, and remedial operations are accomplished by changes produced in the plasma through medicinal substances.

3d. Atmospheric air. Oxidation or slow combustion is a process that may almost be termed vital. Organic or life-actions cannot proceed without this chemical action. The whole of the chemical actions of the animal economy are dependent on the presence of oxygen. The atmosphere contains oxygen in the proportion adapted to the demands of living beings.

Provision has been made for an inexhaustible supply of this essential element of life. From calculations made by Dumas, taking the surface

of the earth, the height of the atmosphere, and the known per centage and weight of the oxygen in it, as the elements of the problem, it is found, that the oxygen of the atmosphere is equal in weight to a column of water 7 ft. 8 in. pressing on every part of the earth's surface. Supposing the population of the globe to be 100,000,000, it would require 10,000 years to produce even a perceptible effect upon the eudiometer of Volta, in the consumption of oxygen and production of carbonic acid. In this calculation the effect of the vegetable world, that purifies the atmosphere of carbonic acid and furnishes it with oxygen, is thrown aside.

The atmosphere is vitiated and contaminated in various ways. Respiration is the most common. Accurate observations have established that from 4 to 5 per cent. of carbonic acid is contained in the air expired by a male adult, and a somewhat larger per centage of oxygen has disappeared. The amount of air passing through the lungs in 24 hours, is about 400 cubic feet, which loses about 20 cubic feet of oxygen, and receives about 16 cubic feet of carbonic acid. The same air breathed three or four times becomes poisonous. One per cent. of carbonic acid in the air, if breathed for some time, is prejudicial; and death has been caused by a vitiation of not more than 12 or 15 per cent.

These facts show the importance of free ventilation to the preservation of health, and the free exercise of the functions, mental and physical.

The quantity of fresh air that should be supplied to each individual, should be from 30 to 40 cubic feet per minute, or from 1800 to 2000 cubic feet per hour. There is a criminal inattention to this matter, most important as respects not only health but comfort, in our domestic and public architecture. In few buildings is provision made for ventilation, and when attempted is mostly inefficient. It is stated by Le Blanc, that in the Chamber of Deputies, in Paris, the system of ventilation furnishes to each individual from 10 to 20 cubic metres (353.16 to 706.331 English cubic feet) per hour, which was supposed to be fully sufficient, yet the air issuing from the apartment was found to contain, when examined, from 2 to 4 parts of carbonic acid per 1000 parts by weight.

In the limits of a lecture it is impossible to enter into details, and I must confine myself to a mere general indication of the sources of the contamination of the air by exhalations from manufactories, by various processes of the arts, and by fermentation and putrefaction. The soil of the earth is a vast compost of decaying animal and vegetable matters, the products of which, if not consumed by high cultivation, converting them by the chemical action of vegetables into food for man and beast, into fruits and flowers, and thousands of other vegetable productions, are exhaled into the air, infecting it with malarial and other poisons, scattering broadcast the seeds of disease and death.

4th. Temperature. Heat is the natural exciter of organic or life-actions; at a low temperature, as around the poles, there reigns eternal sterility and

death. Animals possess a determinate internal temperature; that of the warm-blooded animals is from 98° to 100° F. A few degrees above or below that point is destructive of life. In many diseases the immediate cause of death is the lowering of the animal temperature; at a temperaure of 105 to 110, the blood tends to decomposition and death ensues. An egg will not hatch below 90° F.; it will putrefy at 110°.

From this positive necessity of a fixed temperature in living beings, nature has provided for its production in the interior of the animal economy. Oxygen is introduced into the blood by respiration; the combustibles carbon and hydrogen, elements of food in the products of digestion. They combine chemically and heat is evolved, carbonic acid and water are formed. The heat given out is diffused throughout the economy by the circulation maintaining an equal temperature; the carbonic acid and water are eliminated by the lungs and skin.

The full importance and signification of this fixed temperature of 98° to 100° F., it appears to me, has not been duly realized. Special chemical actions, new arrangements of the molecules of bodies take place at particular temperatures. From the same chemical elements, at different temperatures, entirely different products are obtained. Numerous protoplasmata doubtless exist for the formation of the various tissues. Some of these, as protein, fibrin, and their oxides, chondrin and collin, neurine and mucin, are known. There may be others, yet undiscovered. Albumen may be considered as the crude plasma, from which the others are formed, as is seen in the egg. Now, these transformations by new arrangements of the constituent molecules will not occur so as to constitute perfect protoplasma at a less temperature than the normal standard of 98° to 100°.

The permanent reduction of the animal temperature below 90° is a common cause of chronic wasting diseases, attended with degradation of the organization. This lowering of the animal heat often arises from the use of food deficient in carbon and hydrogen, from starvation, from disorders of the digestive functions, from impure air, and from insufficient clothing, permitting the loss of heat by radiation more rapidly than it can be generated.

The hydro-carbonaceous compounds of cod-liver oil and other fatty bodies thrown into the system, elevate the temperature by their combustion, to the healthy degree, and in this manner produce their beneficial effects in wasting aplastic diseases.

In another point of view animal temperature exhibits its connection with life, and its important operations in the animal economy. Heat is convertible into mechanic force. Engineers know that a bushel of coals properly consumed will produce a force capable of raising seventy millions of pounds a foot high. This is the average performance of an engine at Huel Town, Cornwall. An adult man consumes in his blood from twelve to fourteen ounces of carbon in twenty-four hours. It is converted in him

into mechanic force, estimated by engineers equal to the raising of between three and four millions of pounds a foot high in seventeen working hours.

The daily demands for mechanic power in the animal organism for the maintenance of its functions and in the uses of life, as in respiration, speaking, circulation, deglutition, peristaltic movements, the carrying about of the body, and in labor of various kinds, is enormous. It amounts daily to some hundreds of thousand pounds. The mechanic force and power of the animal organism are directly connected with the process of the evolution of the natural temperature of the body.

The absolute necessity of animal heat (98°) is shown in the foresight with which nature has provided the supplies of combustible materials for that purpose.

Food consists of two distinct kinds: fatty, saccharine and amylaceous, non-azotized substances; and the azotized substances, the protein compounds. The first are calorifacient principles destined to be consumed in the blood; the second are plastic elements, intended for the renovation of the blood and the reproduction and repair of the tissues and organs. The proportion in our aliment of the calorifacient, is as 6 or 7 to one of the plastic principles.

In stating that each of the preceding conditions is indispensable to the existence of life or organic actions, and in their aggregate form a fundamental organic law, common to all organic beings, vegetable and animal, the conclusion has been reached by an analysis of the phenomena of living beings. It is not an hypothesis or an assumption, but a consequence of a rigorous induction from undeniable facts. If this generalization be correct, the law will be found to embrace every phenomenon of organic or nutritive life, and will lie at the root of every pathological or disordered state of the structure and functions of the organs.

In animals, a class of phenomena and a vital law or force are superadded to the foregoing organic phenomena, and organic laws common to them and to plants. They belong to the nervous and muscular systems constructed of special organic elements, and having a special organization: vegetables possess nothing analogous.

The nervous apparatus, the generator of this force, is the spinal marrow and medulla oblongata. They are a dynamic apparatus. The muscular fibre is the mechanical element of life: muscles variously constructed and arranged, are the acting mechanical instruments of life. They are not self-acting, but are excited into action like every other mechanism, by a force exterior to themselves. That force is the excito-motor force of the spinal system. The energy of muscular action and the extent of its power, depend on the sum of motor-force the spinal centres can generate and transmit. It may, therefore, be named the animal acting or mechanic force of life. The higher animals of complex organization, in which the conditions of the organic or vital actions and the exercise of the organic

law or force, depend on functions for the performance of which muscular or mechanic power is indispensable, as respiration, circulation, and in part digestion, hold their existence on the constant activity of this acting mechanic force.

Life has its seat in the organized cells and molecules of the organs. Each is a living organism, and requires the constant maintenance of the conditions or law of organic or vital actions—a germ with its organic force, plasma, oxygen and heat. The organic functions, digestion, respiration, absorption, circulation, secretion, have no other intention but to procure and maintain these conditions for each living atom of the tissues. The acting or mechanic force of the spinal system in the animals of the superior classes, is a vital force; for the conditions of life-actions cannot exist without its operations. The spinal system is an automatic apparatus generating this force, which, independent of the brain, of consciousness, intelligence and the will, excites and directs the actions necessary for existence.

The spinal system, including the medulla oblongata consists of some 126 or 128 centres of motive force. These may act singly or in conjunction; they preside over certain regions, and control special functions; and as they may happen to be variously affected, and act in different groups, the symptoms of disease will exhibit corresponding diversities. From this localization of the acting vital force, life is made dependent on a single centre, the respiratory centre of the medulla oblongata. It may be termed the pivot of the living machinery. While that centre continues in activity death does not take place; the sudden destruction of it is in a moment fatal, as is shown in the bull-fights of Spain, when the matador, plunging his weapon behind the occiput of the enraged animal rushing on him, instantaneously lays him dead at his feet.

The conditions or law for the development and exercise of the anima. acting force are; 1st, Perfect integrity of the spinal centres and conducting nerves; 2nd, The full sum of red blood corpuscles in the blood—for an adult male 130 to 140 parts in 1000; 3d, The blood fully oxygenized and the carbonic acid kept down to its minimum; 4th, The blood maintained free, by the depurating action of the excretory organs, of the accumulation of the effete materials of the tissues, chemically formed in their breaking up and wasting, in the organic and functional actions of life.

This vital force I have been accustomed to term the *income of life;* the spinal and muscular systems, the *capital of life.* The energy, activity, power, and regularity of those functions depending on muscular action, as respiration, speaking, circulation, deglutition, peristaltic movements, and locomotion; the power to accomplish mechanical exertions, to endure labor and fatigue, proceed from the capabilities of the spinal centres as generators of this force. They are the test and metre of the activity and sum of the vital acting force. Every deviation, disturbance, and disorder in the actions of the muscular system at large, or special

muscles attached to a particular apparatus, deranging its functions, have their origin in the spinal centres or their nerves, and the play of this force connected with them.

Adynamia—loss of strength, feeble power ; ataxia—irregular exertion of power, are the results of the deficiency, or disordered exercise of this force. They may be simple nervous affections, or they may complicate other diseases, as malignant, typhus, typhoid and other fevers and diseases, often rendering cases of them fatal.

In the diseases involving or proceeding from this force, some one or more of the conditions of its existence and activity are in fault.

I have presented to you, gentlemen, medicine in the character of a science, as distinguished from an empiric art. I presume you have not been struck with any insurmountable difficulties in the study of it in this aspect. Though its phenomena are often hidden and complex, yet there are modes of bringing them into view and of resolving them into their simple elements. When that is done they are as readily understood as are simple phenomena themselves.

The progress of science is from the compound to the simple. The truth of facts is thus ascertained and settled, and observations acquire precision and accuracy. The relations between phenomena in the order of their occurrence, or as causes and effects, are perceived without difficulty, and can be expressed as a law. Science is no more than facts expressed in laws ; and the evidence that it has gained solid ground, and obtained an advanced position, is the power to generalize its facts into laws.

In the manner in which the subjects discussed in this discourse have been handled, you will have seen the mode which is pursued in my course. Physiological phenomena are analyzed—are reduced to their simplest elements ; they are studied in their origin, as to their offices in the economy and relations with each other. In this manner their true character is discovered, and they are classed as being organic or life-actions, or as chemical, physical, dynamic, mechanical, or psychological. The part each performs in the complicated operations of life, its uses in the animal mechanism, its liability to lapse into derangements of various kinds, and their influence on the whole economy, can then be traced out and discerned without much difficulty. Physiology becomes the basis of Pathology, Therapeutics, and Hygiene, and rises to the elevation of the Institutes or the Philosophy of Medicine. It is the duty assigned to this chair. I feel sensibly that my powers are inadequate to the performance, in the way I could wish, of this important task. But should I succeed in inspiring you with a love of science, and of exciting in you a determination to accomplish yourselves as scientific physicians, the interpreters of God's organic laws for the preservation of health, the assuaging of suffering, and alleviation of man's physical evils, I shall have performed the obligations imposed on me, conferred, through you, a benefit on society, and gratified the height of my ambition.