LECTURE

INTRODUCTORY TO THE COURSE

OF

MEDICAL CHEMISTRY

IN THE

MEDICAL DEPARTMENT

OF

PENNSYLVANIA COLLEGE,

PHILADELPHIA.

FOR THE SESSION 1844-45.

BY WASHINGTON L. ATLEE, M. D.

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CORRESPONDENCE.

Philadelphia, Nov. 13, 1844.

DEAR SIR:

At a meeting of the students of Pennsylvania Medical College, held in the lower lecture room, (Mr. WM. T. BABB, of Penn. in the chair, and Mr. N. C. SKINNER, of North Carolina, Secretary,) the undersigned were appointed a committee on behalf of the class, to request a copy of your introductory lecture for publication.

In performing this pleasing duty, the committee would respectfully request that the wishes of their fellow-students be complied with, and beg leave to add on their own part the sincere desire they feel to witness the publication of your highly eloquent and instructive address.

Very respectfully,

C. A. COWGILL, Delaware.
DANIEL HERSHEY, Penn.
JOHN L. HILL, Ohio.
R. WALTON, Penn.
C. H. LEISTNER, Tennessee.
A. FRAZIER, Penn.

Prof. WASH. L. ATLEE.

Philadelphia, Nov. 15, 1844.

GENTLEMEN:

Your polite note, asking for my introductory lecture for publication, has been received. The lecture was not written with that view, yet as you, to whom it was addressed, consider it "instructive," I yield to your request. Should it tend to disseminate the views contained therein, I shall not regret its publication. I am, gentlemen,

Your obedient and humble servant,

WASHINGTON L. ATLEE.

Messrs. Cowgill,
Hill,
Hershey,
Walton,
Leistner,
Frazier.
} Committee.

GENTLEMEN:

I propose, in this my inaugural lecture, to introduce you to the course of instruction by pointing out a few of the more important relations, which chemistry bears to the science of medicine. The medical student, without due consideration, is apt to look upon chemistry as not only too difficult of study, but irrelevant to the profession in which he is engaged. It will, therefore, be well to undeceive him at the very threshold of the science, and convince him how fatal is the error that leads him to neglect it.

No one can be perfect in medicine without a proper knowledge of chemistry. Man, the very object of our study, is a chemical laboratory of the most perfect character, in which compositions and decompositions are continually going on, modified and regulated, it is true, by the mysterious principle of life. The pious psalmist, in surveying the curious organization of the human frame, did not merely refer to its beautiful anatomical structure, when he exclaimed, "I am fearfully and wonderfully made." He goes on, in grateful adoration, to say, "How precious are thy wonderful contrivances in relation to me! how great is the sum of them!"—alluding, no doubt, to the manifold vital phenomena connected with animal organization and external nature, and which, for their perfect and most happy illustration, require the aid of chemistry. This microcosmical world is every where surrounded by chemical agents, whose uninterrupted influence is intimately blended with all the operations of the vital principle itself. Study it as we may, we must make constant appeals to chemistry to aid us in discovering the hidden treasures in this vast storehouse of knowledge.

The professor of anatomy will dexterously unfold to you the various organs, and reveal the most minute and delicate fibres of the human body; he will point out—

> "———Where the veins their confluent branches bend,
> And milky eddies with the purple blend;
> The chyle's white trunk, diverging from its source,
> Seeks through the vital mass its shining course;
> O'er each red cell, and tissued membrane spreads
> In living net-work all its branching threads;
> Maze within maze its tortuous path pursues,
> Winds into glands, inextricable clues;
> Steals through the stomach's velvet sides, and sips
> The silver surges with a thousand lips;
> Fills each fine pore, pervades each slender hair,
> And drinks salubrious dew-drops from the air."

He will trace out animal organization to its ultimate mathematical point; associate these points into organs; classify these organs into systems; and arrange these systems into one perfect and harmonious whole;—and there he will stop, admiring the wonderful machine, whose various parts have been discovered by the most ardent research and patient industry.

The physiologist, engaged in studying out the science of life, will now take up this machine and examine it under new relations. He will explore the whole of animated nature throughout every link of its vast chain, in order to

" _____ disclose
From what fair fountain mortal life arose,
Whence the fine nerve to move and feel assign'd,
Contractile fibre, and ethereal mind."

Having breathed into his nostrils the breath of life, he will examine man in his noblest attitude—a compound of mind and matter. He will trace out their mysterious connexion both in health and disease; examine into the phenomena of sensation, of the understanding, of memory, judgment, the will, of instinct, of the passions. He will study the voice and its various modifications, muscular motion, digestion, respiration, circulation, secretion, and nutrition. And finally he will conclude by investigating the hidden phenomena of generation, sleep, and death.

Thus anatomy, physiology, and pathology, hand in hand, will lay open some of the most valued arcana of the mysterious structure and functions of man. And yet how imperfect will be the work! It is not until the talismanic touch of *chemistry* is applied that this enigmatical organism will open out all its mystic treasures. Unlike the physiological and pathological anatomist, the chemist goes beyond the field of organic structure to explore organic nature and animal life. He sees that—

"In earth, sea, air, around, below, above;
Life's subtle woof in Nature's loom is wove."

He is not content in merely studying, anatomically, animal organization, beautiful, captivating, and essential as such study is; but having studied it, he goes to work analytically. He examines the elementary constitution of the blood; of every tissue, of every secretion and excretion; he investigates the composition of the food we eat, of the water we drink, of the air we breathe; he studies the effects of affinities, the operations of heat, and the influence of light; and estimates the controlling agency of the great principle of life. Thus, with the knowledge of the elements within, he takes, as it were, an inventory of his stock, opens accounts of debits and credits with the elements without, and estimates, with almost mathematical precision, the loss and gain upon each entry. He traces every chemical agent in its circuitous path throughout the system, in its course attracting or repelling—at one moment aiding in nutrition, the next passing off in waste—now seen in mass in the stomach, then detected in its ultimate divisions in the minutest fibrils of organic texture—here associated in the bile, there in the urine, and again engaged in supporting respiration. He observes it fulfilling harmoniously its multiform offices in health, and detects its numerous aberrations in disease. He traces out its whole history in the organized world, under every possible condition, from the cradle to the grave, and even in death, when the *vis vitæ* gives way to other powers, he watches it in the dissolution of matter, and though scattered to the four winds of heaven, he sees it again becoming re-vivified in a thousand forms—in vegetable mucor, in the microscopic insect, in the noble forest tree, or in his fellow-man—again to take its perpetual round. Thus—

" ———O'er the wreck, emerging from the storm,
Immortal Nature lifts her changeful form,
Mounts from her funeral pyre on wings of flame,
And soars and shines, another and the same."

In this never-ceasing circulation of matter in growth and dissolution the metempsychosis of Pythagoras has its prototype, and the curious fable of

antiquity, of Jupiter throwing down a large handful of souls upon the earth to scramble for the few bodies that were to be had, has its reality.

"The most exact anatomical knowledge of the structure of the tissues cannot teach us their uses; and from the microscopical examination of the most minute reticulations of the vessels we can learn no more as to their functions than we have learned concerning vision from counting the surfaces on the eye of the fly. The most beautiful and elevated problem for the human intellect, the discovery of the laws of vitality, cannot be resolved, nay, cannot even be imagined, without an accurate knowledge of chemical forces; of those forces which do not act at sensible distances; which are manifested in the same way as those ultimate causes by which the vital phenomena are determined; and which are invariably found active, whenever dissimilar substances come into contact."—[Liebig.]

Thus we see that chemistry is as closely related to physiology as it is to physics, and that no rational pathology can be known without it. It opens one of the widest fields of inquiry; it causes physiology and pathology to spring into new life and vigour; it establishes medicine upon a surer foundation; it explains, on well established principles, the mysticisms of ages; and now takes its stand in medical science, as in many other sciences, as one of the foundation pillars upon which it rests.

> "Effusive source of evidence and truth!
> A lustre shedding o'er th' ennobled mind,
> Stronger than summer-noon;——————
> Without thee, what were unenlightened man?
> A savage roaming through the woods and wilds,
> Rough-clad, devoid of every finer art
> And elegance of life."

Let me now, gentlemen, point out some of the relations of chemistry to medicine, by taking a general view of several of the more important chemical agents, to which I shall call your particular attention in the progress of the succeeding lectures.

Among the imponderables there is none, perhaps, possessing more value, in a practical point of view, than *Caloric*. This agent, in its various relations of heat and cold, has a most extensive influence on the animal economy. The climate of a region or country is very much affected by temperature, which always enters into the estimate in considering its beneficial or injurious influence on the health and lives of the inhabitants. The annual mean, and the extremes of the thermometer are always regarded in considering the climatic character of a place. The effects of inland tracts, of coasts, of water; the difference of western and eastern coasts of the same latitude; the condensation of vapour, and vaporization of water; all are to be estimated in relation to heat in considering the climate of any country. In reference to pulmonary, rheumatic, scrofulous, and paralytic invalids, the temperature of a climate is of vital importance. Atmospheric equability, or vicissitude of temperature, is also closely connected with the health of individuals, as we know that invalids, and those with delicate constitutions, often appreciate the slightest alterations in the condition of the atmosphere. The effect, also, of the seasons upon human health resolves itself, principally, into that of temperature. The influence of clothing—the texture and colour, as affecting their power of conducting caloric—is, also, of much moment in consideration with climate, the seasons, and vicissitudes of temperature.

Caloric is, also, a most valuable therapeutic and hygienic agent. In the

form of heat, it is employed to cause an afflux of blood to a part; to promote the general circulation; to relax tense, rigid, and contracted tissues; to alleviate pain; to hasten organic changes; and to destroy the vitality of a part. In the form of cold, it is used to lessen preternatural heat; to reduce excessive vascular action; to allay exalted sensibility and pain; to constringe the living tissues; to make a sudden and powerful impression on the nervous system; and to strengthen or give tone to a part or the whole body. It is employed for these purposes both internally and externally, and is very extensively applicable in the form of baths. The power of heat and cold, when applied as remedial agents, may be inferred from the fact that beyond a certain degree they may cause inflammation or apoplexy, and may decompose the animal tissues by their chemical influence. Within certain limits, however, caloric is a vital stimulus.

The evolution of animal heat, a question which has engaged the attention of physiologists of every age and country, and one of vital importance in the practice of medicine, cannot be comprehended without a knowledge of chemistry. The paradox—that the human body is a heated mass bearing the same relation to surrounding objects as any other heated mass, and yet its temperature being invariably the same in all climates, at the equator or at the poles—is beautifully explained. There is a physiological connexion, also, between animal heat and appetite for food, and, under certain relations, clothing becomes merely an equivalent for a certain amount of nourishment. The naked Samoyede, hunting or fishing in the colds of Siberia, may astonish the warmly clad traveller, in taking at a single meal, ten pounds of flesh, a dozen of tallow candles, and a proper proportion of train oil, without bad effects, but the enlightened chemist knows that the carbon and hydrogen of these substances only suffice to keep up the equilibrium between the external temperature and that of his body.

Light, another of the imponderable agents, though not so extensively applicable in medicine, is, notwithstanding, possessed of considerable influence. It acts as a vivifying stimulus to living beings; promotes their developement and nutrition; and stimulates the eye by a specific power. Diseases have arisen both from excess and privation of light. In all diseases of the eye attended with local, vascular, or nervous excitement; in inflammatory conditions of the brain; in fever; mental irritation; after parturition, severe wounds, and surgical operations; the stimulus of light proves injurious.

Exposure to solar light is indicated in maladies characterized by imperfect nutrition and sanguification—as scrofula, rickets, anœmia, and in weakly subjects generally. Dr. Edwards is of opinion that in climates, where nudity is not incompatible with health, exposure of the whole body to light is favourable to the regular configuration of the body; and he suggests insolation in the open air as a means calculated to restore healthy conformation in children affected with scrofula. We all feel more active, cheerful, and happy, in days illuminated with bright solar light, and gloomy and depressed in days of obscurity and darkness. The enlightened physician, therefore, employs insolation in the open air as a mental stimulus in melancholy, lowness of spirits, and despondency.

"————————Prime cheerer, Light!
Of all material beings first, and best!
Efflux divine! Nature's resplendent robe!
Without whose vesting beauty all were wrapt
In unessential gloom."

Exposure of the eye, suddenly, to a strong light—as to a vivid flash of lightning in a dark night—is occasionally followed by blindness and intense suffering. A melancholy instance of extreme agony from intensity of light is familiar to the classical student:—Regulus, faithful to the custom of the age, returned into the hands of the Carthagenians, who, casting him into utter darkness and cutting off his eyelids, subjected him to the cruel and exquisite torture of suddenly exposing him to the full and direct glare of the meridian sun.

The effects of light are daily seen upon many chemical preparations; upon the human countenance; and, according to some anthropologists, upon the different races of man. They are seen in the sombre tints of northern vegetation, and in the dull clothing of arctic animals; in the gaudy exterior of the tropical bird, and in the rich foliage and efflorescence of the equatorial plant.

> "———————— For Nature's hand,
> That with a sportive vanity has deck'd
> The plumy nations, there her gayest hues
> Profusely pours.————————
> One boundless blush, one white empurpled shower
> Of mingled blossoms."————————

It is light that creates those "breathing prospects," which compel the poet to exclaim—

> ————————Who can paint
> Like Nature? Can imagination boast,
> Amid its gay creation, hues like hers?
> Or can it mix them with that matchless skill,
> And lose them in each other, as appears
> In every bud that blows?"

Electricity, another of the imponderable agents, has long been suspected, by physiologists, to be the cause of some vital phenomena. The extensive agency of this force in physical and chemical operations, its well known remarkable influence on the animal economy, and its developement by certain fishes, would give countenance and plausibility to this notion. It has been extensively applied as a therapeutic means in the form of the electric bath, the electric aura, the electric spark, the electric shock, and the electric current. It has been communicated by friction electricity, voltaic and magnetic electricity, and into the substance of the tissues by means of electro-puncture. It is a most valuable agent in nervous diseases generally. It also promotes secretion and absorption; stimulates to muscular contraction; and, according to Dr. Wilson Philip, has been useful in asthma and dyspepsia. It is likewise employed to electrolyze urinary calculi; to coagulate the blood in aneurismal tumours; for cauterization; and to promote the absorption of medicinal substances.

The electrical condition of the atmosphere and of the animal body is supposed, also, to be intimately connected with animal health; and, no doubt, our feelings are sometimes affected by this circumstance, as many persons experience a manifest difference in the performance of their functions when the air is highly electric—they are apt to suffer from headaches and pains of various kinds to which they may be subject. Indeed, Dr. Forster is of opinion, that it is not the heat, nor cold, nor dampness, nor drought of the air, which is chiefly concerned in producing disorders, nor the sudden transitions from one to another of these states—but that it is some inexplicable peculiarity in its electric state.

Electricity is one of the most powerful agents in the hands of the chemist. Since the discovery, by Messrs. Carlisle and Nicholson, that the voltaic apparatus is the most powerful instrument for analysis, many able experimenters have employed it in their researches, and the alkalies and earths, which had previously been regarded as elementary bodies, yielded up their compound character to this powerful agent in the hands of Sir Humphrey Davy:—exhibiting a happy and successful instance of philosophical induction. In the vast laboratory of nature it is incessantly operating upon the molecules of matter, and quietly producing changes in the mass; while, occasionally, it bursts forth with terrific grandeur, and displays its power to an alarming extent. Examples of this kind must be familiar to all; but there is a memorable instance of the latter recorded in the poem of Darwin:—Professor Richman, of Petersburg, while repeating in 1763, the experiment which had been previously performed by Franklin in this city, was watching his electrometer, suspended to an insulated lightning rod, and, approaching with his head too near to the conductor, was struck dead amidst his family by the explosion of a thunderbolt. The poet thus writes:

"When Richman rear'd, by fearless haste betrayed,
The wiry rod in Nieva's fatal shade;—
Clouds o'er the sage with fringed skirts succeed,
Flash follows flash, the warning corks recede;
Near and more near he eyed with fond amaze
The silver streams, and watch'd the sapphire blaze;
Then burst the steel, the dart electric sped,
And the bold sage lay number'd with the dead!"

You see, gentlemen, from these mere allusions to the therapeutic application of the imponderables, that there is an intimate relation between their chemical properties and the practice of medicine, and that the latter cannot be properly pursued without a knowledge of the former. Indeed, with attraction, they are the great propelling influences of universal nature, operating on the material world in every molecular change, as well as in the grand cycles of creation; their—

"——unremitting energy, pervades,
Adjusts, sustains, and agitates the whole."

But when we pass from these to more tangible objects, the very close relation between chemistry and medicine will be more readily comprehended:—

Oxygen, so widely distributed over the face of nature, is essential to our existence. We are taking it into our system, by respiration, at every moment of our lives, and it is carried by the arterial blood to all parts of the body, infusing life and energy into every fibre. It is essential to digestion; to the change of matter within the body; to the production of muscular force; to the causation of animal heat, and of the waste of matter. Its deficiency tends to the formation of fat, while its action causes death in chronic disease and in starvation. It is the vital principle of the air we breathe, of the water we drink, and a constituent of all we eat. It is incorporated with every part of the animal fibre; exists in every secretion and excretion; and is chemically active in most of the physiological and pathological changes throughout the system.

As a remedial agent oxygen is useful, although too exaggerated notions of its medicinal powers formerly prevailed. Dr. Hill, however, found it beneficial in asthma, debility, ulcers, gangrene, white swelling, and scrofu-

lous diseases of the bones. Although the notions of its superior power have been exploded, it nevertheless is worthy of remark that nearly every article of the materia medica, of a chemical character, owes its active medicinal properties to the direct or remote agency of oxygen. Look, for instance, at the class of calcigenous metals, which, in their combinations, compose so large a number in the list of medicines, and see how few of them possess active properties in their metallic state. But subject them to the action of oxygen, and at once they become therapeutic agents of inestimable value. So with the kaligenous and terrigenous metals. But the medicating influence of oxygen on the metals does not stop here. It converts them into salifiable bases, and thus, and thus only, enables them to form new combinations of almost unlimited extent and value. Even the non-metallic simple substances mainly depend upon oxygen for their medicinal properties, as we see, directly, in most of the acids, and, remotely, in their manifold combinations with oxidized bases.

Oxygen constitutes three-fourths of the known terraqueous globe, is the most active agent in nature, and is chemically interested in most of the changes of the material world. In ancient mythology it was represented by Jupiter, and its affinities were probably portrayed by the Magi of Egypt, in their hieroglyphic pictures, by the loves of Jupiter with the terrestrial ladies.

Chlorine is, also, a medicinal agent of importance. Its physiological effects on the human system have been investigated by Mr. Wallace, who informs us that when applied to the skin it produces sensations similar to the sting of insects, and sometimes minute papulæ, and vesicles. All, who have accidentally respired undiluted chlorine gas, will remember the spasm of the glottis, which it produced, and, when mixed with air, the sensation of tightness and suffocation, and violent cough. Its remote effects are increased frequency of the pulse and respiration. It stands unrivalled as a fumigating, disinfecting, and antiseptic agent. It is the most powerful agent known for destroying miasmata, noxious effluvia, and putrid odours. It is employed, and acts chemically, as an antidote in poisoning by hydrocyanic acid, sulphuretted hydrogen, or hydrosulphate of ammonia. It is useful in chronic, pulmonary, and hepatic diseases of various forms, in cutaneous diseases, in putrid and fetid ulcers, in wounds caused by rabid animals, in putrid diseases generally—as typhus, scarlet fever, &c. Like oxygen, its chemical combination with the metals forms some of the most valuable medicines of the materia medica.

Iodine is another element among the non-metallic class of bodies, which is assuming an important rank in medicine. It possesses great powers over the animal economy, and, since its discovery in 1811, has been most extensively and beneficially employed, by itself and in combination with other substances, in a great many forms of disease, both external and internal. Indeed its various chemical combinations are so many forms of useful medicines.

Hydrogen, considered as a medicinal agent, has not been used extensively, although it has been employed in pulmonary consumption, rheumatism, paralysis, and as a caustic while burning. It, however, possesses important physiological relations to the animal system, inasmuch as it is essential to the existence of organic matter. Next to oxygen it may be regarded as the most important constituent of the terraqueous globe, and one of the most wide-spread elements in nature, existing in both kingdoms, organized and inorganized. It enters as an element into all our food, and is

essentially incorporated with all fluids and solids of our bodies, and contributes towards the production of animal heat.

In combination with oxygen, in the shape of *water*, it forms one of the most important chemical, therapeutic, and hygienic agents known. In this union it contributes to the health and comfort of all animal creation; to the growth and nutrition of vegetables; to the salubrity of the atmosphere; and to the character of climates. It is indispensable in a dietetical point of view; valuable as an agent for the communication or abstraction of heat to or from the body; and serves as a diluent, humectant, emollient, evacuant, and, in pharmacy, as a solvent. It is itself a valuable medicine, and, in its various combinations with caloric, it subserves a variety of the most valuable purposes. In Germany, indeed, under the name of *hydropathy*, it is regarded as a universal remedy, curing inflammations of the brain, chest, and abdomen, insanity, epilepsy, phthisis, gout, rheumatism, all exanthematous and cutaneous diseases, hemorrhages, alvine obstructions, syphilis, scrofula, neuralgia, &c. &c.—and even hydrophobia, the very *water-horror* itself, is effectually cured by this wonder-working *water-medicine!* whether by *submersion*, continued until the spasm has been *permanently* subdued or not, I have not been informed. Still, notwithstanding the enthusiasm of the followers of the "primitive philosopher," Priessnitz, we may truly exclaim with Southey,—

> "Most blessed water! Neither tongue can tell
> The blessedness thereof, nor heart can think,
> Save only those to whom it hath been given
> To taste of that divinest gift of heaven.
> I stopped and drank of that divinest well,
> Fresh from the rock of ages where it ran;
> It had a heavenly quality to quell
> All pain. I rose a renovated man;
> And would not now, when that relief was known,
> For worlds the needful suffering have foregone."

Although hydrogen forms, with oxygen, one of the most bland and salubrious fluids, yet in combination with chlorine it produces one of the most corrosive, and which is exceedingly valuable as a medicine, acting as a disinfectant, tonic, refrigerant, diuretic, and externally, as a caustic and detergent. It is, also, an active agent in digestion, existing in a free state in the gastric fluid. In its union with bases, likewise, its medicinal properties are considerably extended, and with soda, as in culinary salt, it serves some important and essential uses in the animal economy.

Nitrogen, although an element apparently inactive, is of great importance in animal organization. It is the principal ingredient of the atmosphere, and serves as a diluent to oxygen in respiration. It is an essential element in animal nutrition, and a characteristic and large constituent of animal matter. All portions of an animal body having a decided shape, forming parts of organs, contain nitrogen, and chemical researches have shown, that all such parts of vegetables as can afford nutriment to animals contain certain constituents rich in nitrogen, and that animals cannot be fed on matters destitute of nitrogenized constituents.

A remarkable fact, which gives additional importance to nitrogen, is, that the medicinal *nitrogenized* vegetable principles, produced by a vegetable organism, are distinguished, beyond all others, for their powerful action on the animal economy. With the exception perhaps of three, all these substances produce diseased conditions in the healthy organism, and are poi-

sonous in certain doses. No remedy, devoid of nitrogen, possesses a poisonous action in a similar dose, and the medicinal or poisonous action of the nitrogenized principles has with few exceptions a fixed relation to their composition.

In combination with oxygen it forms several interesting compounds, possessing very active properties, and employed medicinally, both internally and externally. One of these compounds is the *atmosphere*, which surrounds the earth, and which,—as the recipient of all vapours and effluvia; the carrier of miasms; the theatre of thermometric, barometric, hygrometric, and electric changes; the great and necessary internuncio of healthful action between the vegetable and animal worlds; the supporter of the vital functions of both; and as the medium of many, and the promoter of most of the terrestrial chemical changes—assumes peculiar importance in a physiological, pathological, and hygienic point of view. Other compounds of nitrogen and oxygen are much more active, possessing valuable medicinal properties, and, when united with the salifiable bases, form numerous useful therapeutic agents.

When combined with hydrogen, nitrogen forms an alkali of considerable value in the materia medica, employed both internally and externally. This alkali, also, forms a large list of medicines when united with other substances, and which are applicable to a great many forms of disease.

Sulphur, another of the non-metallic bodies, as one of the elements of albumen and caseine, is possessed of much physiological importance, and is a medicinal agent of valuable properties. All the animal tissues, excepting the cellular and membranous, contain sulphur, and this is converted into sulphuric acid by the oxygen of the arterial blood, and is finally found in the urine in the form of a sulphate.

Like nitrogen, when combined with oxygen, sulphur forms compounds of the most energetic character, and of extensive therapeutic application, and the combination of these with bases constitute some of the most valuable articles in the materia medica.

With hydrogen it forms an exceedingly deleterious compound in the form of a gas, which, mixed with the atmosphere, even in the proportion of one-one hundred and fiftieth part, proved fatal to a horse, and to a bird when the dilution was ten times greater. It puts a stop to all the phenomena of motion in a few seconds, and its frightful effects are explained by its well-known action on the compounds of iron, when alkalies are present; and free alkali and iron are never absent from the blood. There is a well grounded supposition that the injurious effects of malarious districts are dependent upon the presence of this compound gas; and should this prove to be the case, it will afford a beautiful explanation of the manner by which chlorine acts the part of a disinfecting agent.

Phosphorus, like sulphur, is an element of albumen and caseine, and exists in all the tissues, except the cellular and membranous, and is found abundantly in the urine; having been derived from the metamorphosed tissues, it enters into the venous blood in the form of soluble salts, and is separated from it in its passage through the kidneys. It is, also, an essential constituent of brain and nervous matter, and a large ingredient of the bones; and in the graminivora, whose food contains so small a proportion of phosphorus or of phosphates, the organism collects all the soluble phosphates produced by the metamorphosis of tissues, and employs them for the developement of the bones and of the phosphorized constituents of the brain.

In medicine it is a powerful and diffusible stimulant, exciting the ner-

vous, vascular, and secreting organs, and has been recommended in a variety of diseases.

With oxygen it forms a tonic and refrigerant compound, which, when compared with sulphuric acid, is thought to be less heterogeneous to the human organism, since it has a greater share in its composition. This compound in union with some of the bases, particularly lime, is also applied therapeutically.

There is no agent, perhaps, possessed of more importance in the physiology of organized matter, than carbon. It is an essential constituent of all vegetable and animal matter, and is intimately concerned in the process of respiration, being constantly eliminated from the lungs and the skin. The carbon of the metamorphosed tissues accumulates in the bile, and returns during the digestive process into the circulation, and serves for respiration and for the production of animal heat. There is, also, a direct relation between the carbon consumed in the shape of food, the carbonic acid expired, and the condition of health, and if the waste is not proportioned to the amount of carbon taken in, disease of some kind ensues.

Carbon, in the form of charcoal, is supposed by many to be valuable in many chronic diseases, while others consider that there is no foundation for the properties and virtues which have been ascribed to it. Burdin gave one pound of it daily without effect, while a standard work on homœopathy enriches no less than thirty-five of its pages in enumerating the symptoms produced by one-millionth of a grain of this substance!!

In combination with oxygen it becomes gaseous at the ordinary barometric pressure, and in this state is exceedingly deleterious to animal life. It is this which characterizes the *Grotto del Cane*, near Naples, so destructive to animals; the *lake of Averno*, which Virgil supposed to be the entrance to the infernal regions; and the *valley of Poison*, in Java, whose soil is whitened by its victims' bones—a strange commingling of the beasts of the fields with the lords of creation. It is this which constitutes the *Choke-damp* of mines and wells, and fatal atmosphere of lime-kilns. It is this, generated largely by respiration, that did its devastating work in the Black Hole at Calcutta; in St. Martin's round-house in London; and still executes, even surrounded with the air and light of a Christian world, its dreadful and horrible mortality, in the crowded prisons of the slave-ship. It is this which causes the unconscious sleep of death in the chambers of the ignorant, with their charcoal fires; and this was the deadly weapon used by the younger Berthollet to rid himself of a miserable existence. But destructive as this gas is when invading the system through the lungs, it is most grateful to the stomach—particularly when introduced by effervescing saline draughts, and in the salubrious and sparkling form of many of our mineral waters. As a medicine it possesses most valuable properties, both alone and in combination with its various bases.

Carbon, when united with hydrogen, forms that interesting compound, which permeates and illuminates this city. It also constitutes the fatal *fire-damp* of coal mines, so destructive to miners before the time of Sir Humphrey Davy, who—by a train of elaborate experiment and close reasoning, the happiest efforts of his genius—invented the *safety-lamp*, "one of the proudest gifts of science to humanity."

When combined with nitrogen, carbon forms a gas, which, in union with several metals, constitutes some valuable therapeutic agents.

When, however, it is combined with both hydrogen and nitrogen, it forms one of the most deadly poisons known to man. How strange, that in every

instance, here alluded to, of these destructive agents, they are constituted of the very same elements, which are employed in forming our own bodies, and upon which, in proper proportion, our health and existence depend. And more strange, the antidote of this fatal compound of carbon, hydrogen, and nitrogen is *itself* a compound of the *two* latter elements. And yet stranger still, a union of the antidote with the poison constitutes another powerful poison, differing in form, but having precisely the same elements of that for which the antidote was administered. Truly, we are "fearfully and wonderfully made."—This dreadful poison, however, has been introduced into the materia medica by the Italians, and, with many other poisons, notwithstanding the ranting of ignorant and venal charlatans, has become, under proper regulations, a therapeutic agent of unquestionable value.

But, gentlemen, I must stop here in tracing out the relations which chemistry bears to medicine, even in the general way that I have been pursuing. The limits of an introductory lecture are too small to embrace the outlines of the whole field of consanguinity between these sister sciences. Enough, I think, has been shown, in considering these few articles of the class of non-metallic simple bodies, and their combinations with each other, to prove that their intimate relationship to the practice of medicine is based upon something more substantial than mere assertion; and, from this hasty and imperfect view, to infer that the bonds of union between chemistry and medicine are one and inseparable, and that the latter are wedded together, like—

"———those whom love cements in holy faith,"

and protected by the same sacred command—"What God hath joined together, let no man put asunder."

I might, gentlemen, if time permitted, go on in this general way, and take up that extensive class of simple bodies, the *metals* and their combinations with the non-metallic substances, and with one another. And I might still farther pursue the inquiry throughout the range of organic nature, in proof of the alliance between chemistry and medicine. But this I am convinced, after what has already been said, would be a work of supererogation, and one, too, almost interminable in its accomplishment. Look, for instance, at potassium, sodium, calcium, magnesium, iron, zinc, antimony, copper, lead, mercury, silver, gold, &c., and their combinations with oxygen, with chlorine, with iodine; and the ulterior compounds formed between the oxides and acids;—look at the numberless organic acids, and organic bases, their union with each other, and with the mineral acids and bases; pervading the materia medica, and enriching it with material for the practitioner. All these are chemical combinations, depending, for their formation, on well established chemical laws, to be understood only by a proper knowledge of chemistry. Their application in pharmacy; their employment in disease; their chemical action upon the system; their changes within it; their incompatibility with one another; their toxical, antidotal, and prophylactic properties; must be known to the well-qualified practitioner, and are known alone to him, who has been enlightened by that branch of study, which I have the honour to teach.

You perceive, gentlemen, even from this hasty and very general view, that the relations of chemistry to medicine are numerous, extensive, and vitally important. These relations will be particularly referred to while considering each article in the ensuing course of lectures. It is time, I think, that MEDICAL CHEMISTRY should be taught in *medical* schools, as it is entitled to para-

mount importance to the *medical* student. What is the great object of the student in coming here? Is it to devote his time to the study of metallurgy; of assaying and refining of metals; to be instructed upon alloys and amalgams; to learn the art of tanning, dyeing, bleaching, calico-printing and a hundred other things unconnected with his profession? Or, is it to prepare himself for the correct treatment of the sick; for the preservation of public health; to get a knowledge of the human system in health and in disease; to understand its physiological, pathological, and chemical conditions; to comprehend the action of agents upon the system, and to study the chemical constitution of these agents themselves? I need not await the answer. His first and bounden duty is fully to qualify himself for the Divine Art of Healing. He cannot be too well grounded in *medical* knowledge; and all his studies, during the short period of three probationary years, ought to bear directly to that end. His great aim once accomplished, and well accomplished, then the foundation stone, that is laid here in building up medical chemistry, will serve him for the superstructure of any other—then, and not till then, will he be doing his duty, both to the profession, and to the community, in appropriating time to other branches, and in aiding the advancement of other forms of science. And what it is useless to study, is it not wrong to teach? Ought not instruction to a medical class be confined to that only which has a relation, more or less direct, with the science of medicine? Look at man, his peculiar organization, his various functions in health and disease, their relations to electricity, caloric, light, air, water, food, medicine, clothing, and a variety of agents operating chemically upon that organization and those functions—look at his associations with the lower animals, his dependence upon the vegetable world; trace out the many links of his own elements, and between these and the elements around him; and truly, chemically considered, he is, alone, a world of study, demanding the students' exclusive attention. Why, then, tax the mind with those branches of chemistry entirely irrelevant to the profession? Instead of aiding in accomplishing the great and all-important purpose of his matriculation, it has a tendency to thwart it—to establish the belief, so fatal to this essential part of medical education, that chemistry is not only uninteresting and difficult of study, but also useless to the practitioner. But when every step taken in this branch is one step more towards the consummation of that purpose, then it infuses into the study a deep-felt interest, a sense of its utility, and the difficulties of the science pass rapidly away and are lost in the progressive acquirement of useful professional truths. His attention being thus directed to the points of intersection between chemistry and medicine, he will soon become convinced of the truth of the observation announced before, that no one can be an enlightened physician without a knowledge of chemistry.

Impressed with these views, I intend, gentlemen, to teach medical chemistry, in the proper acceptation of that term. Of course, the great principles of the science being common to every branch of chemistry, belong as much to this as to any other, and will receive our attention at the earliest period of the course. Then will follow the consideration of imponderable substances, after which the simple bodies, non-metallic and metallic, and finally organic chemistry. I shall spend no time in exhibiting the chemical character of any substance having no medicinal properties, or no physiological, pathological or hygienic relations to the animal system. Still, I have arranged upon an extensive series of tables, which will be always suspended before you, the whole list of chemical substances and their com-

binations, whose symbol, equivalent number, and composition, you can read with a glance of the eye, and upon which tables will also be indicated by a particular mark the articles to which I shall expect you to devote particular attention.

To illustrate my lectures I intend using a new, easy, and lucid system of diagrams to explain the rationale of every chemical process. I shall, also, adopt, for the first time in this country, the chemical abacus as a means of instruction, and, likewise, employ the cubic representatives of bodies in every case in which they are applicable. In addition, I will, when practicable, always elucidate my subject by experiment, in the simplest manner, avoiding, as much as possible, a display of apparatus.

By thus bringing as much to the eye as it is possible in a course of this kind, I flatter myself to be able to make the lectures interesting, useful, and easily understood; and I have no doubt that you will not only acquire a knowledge of this beautiful science, but also a taste for it, that will induce you to prosecute its study with the same zeal and profit as that of any other branch of medicine.

Gentlemen, I trust that the method to be adopted in this course will be such as to meet your approbation, and to convince you that chemistry, when properly studied, is not that difficult and abstruse part of medical education, which the student so often fears to approach, and whose diplomated honours he frequently receives without possessing even a knowledge of its rudiments. I know that the industrious student has merely to will—to open his mind to the reception of truth—and the principles of this useful science will flow in, and captivate his soul with the richest beauties in philosophy. Then, the details of the study will minister gratuitously to his pleasure, and the key to a world of science will be in his possession—for there is no branch of natural science or philosophy, whose study is not aided by a knowledge of chemistry. The current, though fallacious, opinion among students, that it is too hard a study, that it is useless in the practice of medicine, that ignorance of it will not affect the chances of graduation, has done much towards producing apathy, and restraining those noble efforts of the young mind, which, properly cultivated and directed, might have laid the foundation of endless resources of self-gratification, and of boundless benefits to the community.

Gentlemen, your greatest aim now is to reach the goal that awaits you at the termination of your collegiate course of medical studies. May that be consummated equally creditable to yourselves and honourable to the profession. This will, however, be a new era in your existence. Your position in society will be entirely altered—and how sudden must be that change!—to-day, a recluse in the study, a novice in the art of healing—to-morrow, unfurling your parchment to the world, inscribed "*Doctorem in Arte Medendi*," assuming all the responsibilities of a new station, and dispensing relief to suffering humanity. The goal is passed—you all start fairly before the world, on the merits of a diploma, to run the race of fortune and of fame. The starting point is the same to all—at least, so says your *Alma Mater*—but, in the vista of the future, how varied is your position! And why is it so? Perhaps, circumstances, unconnected with your medical education, may, in some instances, explain it. But will they in all? The diploma certifies to qualifications in every branch of medicine, and yet, I fear, that all who receive this document, do not merit this unqualified praise. Professional reputation and success, however, will, in a great measure, depend upon the veracity of this paper, and he, who conscientiously qualifies

himself to deserve its testimony, is most likely to arrive at an elevated position in the profession—and *vice versa.* This want of agreement between the merits of the graduate and the testimony of his diploma, has been most observable in the branch which I shall endeavour to teach, and if I should do aught towards harmonizing such discrepancies, I shall feel gratified at having been instrumental in contributing towards your professional standing.

As Chemistry is rapidly becoming a branch of popular education, medical men must expect to be surrounded by a people possessing sufficient chemical knowledge to estimate their characters, at least as chemists. And should it be discovered that upon this branch they are grossly ignorant, what value will be placed upon the evidence offered in their diploma with regard to the other branches of their medical education? What the inference?—Ignorant in this, deficient in all. Ay, gentlemen, where is the credit, the honesty of procuring testimonials undeserved?—No sensitive, no honourable mind can receive them without experiencing uncomfortable convictions of unworthiness.

Then, gentlemen, as you regard the high position you desire to occupy in society—as you value the resources of self-gratification in unfolding the arcana of Nature—as you esteem the elevated character of your profession—as your great aim is the alleviation of human suffering and the promotion of human health—and as honest, honourable, and conscientious men—cultivate this branch of your education with becoming zeal; at least, with the same spirit that is devoted to other branches of your studies. Be assured, it will make you no worse physicians—but much more useful men. It will give to you a standing in the profession and in society, to which they, who are ignorant of it, cannot possibly attain. There are times when human life must fall a sacrifice to inexcusable ignorance of its first elements—when the preservation of health and life necessarily depends upon it;—there are times when virtue and innocence require its protecting shield—when covert crime, hidden to other forms of scrutiny, is unmasked by it to the noonday sun;—there are a thousand influences within and around us operating on this intricate organization, for weal or for wo, which it alone recognises and controls. It will give to you an elevated position in the community as citizens. Agriculture, the arts, the sciences, are all dependent upon it, and timely hints thrown out by the way-side while pursuing your professional duties, will add much to the common stock of knowledge, to the intelligence and welfare of that community, and will surely revert, with tenfold gain, to its original source. With the well-merited honours of the school, an honourable ambition for professional fame, and a strong desire and determination to be useful, you can then go forward confidently and without a chiding conscience to secure the reward of your high and noble calling.