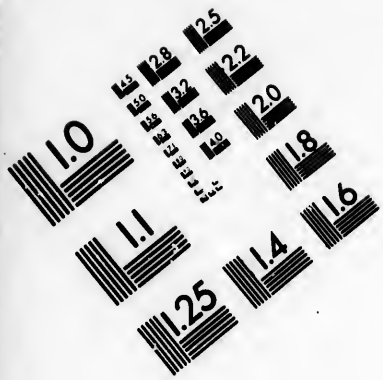

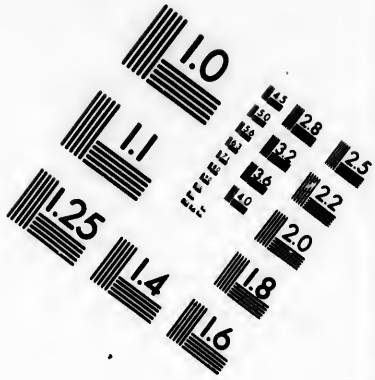

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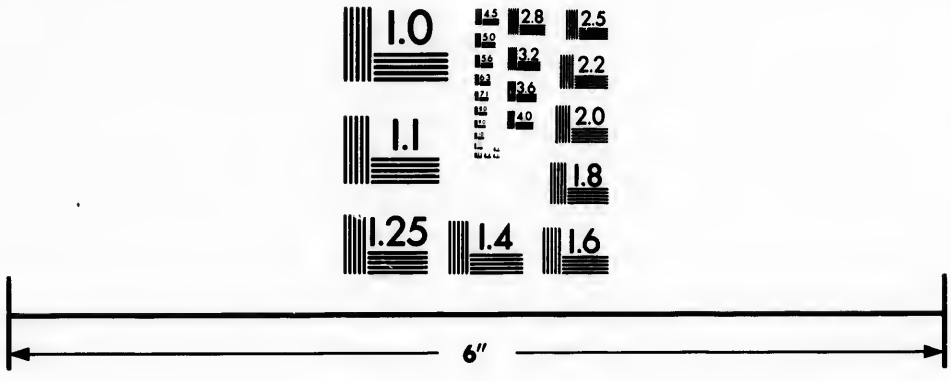

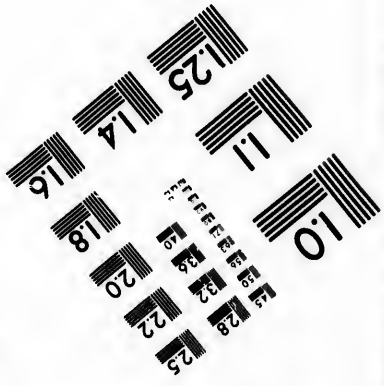

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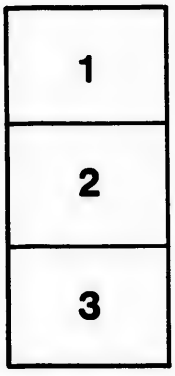

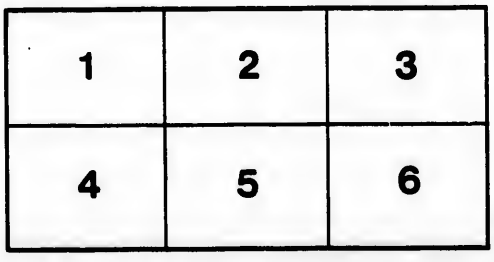

Ruttan, R. F.

THE PLACE OF CHEMISTRY IN A MEDICAL EDUCATION.

THE INTRODUCTORY LECTURE IN THE FACULTY OF MEDICINE OF McGILL UNIVERSITY FOR THE SESSION OF 1893-94.

BY

PROF. R. F. RUTTAN.

(*Reprinted from the Montreal Medical Journal, November*, 1893.)

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The Introductory Lecture in the Faculty of Medicine of McGill University for the Session of 1893–94.

By Prof. R. F. RUTTAN.

We meet to-day in conformity with the well established custom of our Faculty to inaugurate by a lecture the session of 1893–94. To-day we plant the sixty-first milestone which marks the progress and development of our school. I need not tell you with what gratification I find myself, though almost the junior member of the Faculty, in the position which my colleagues have been courteous enough to assign to me—a gratification which would be complete were it not for the sense of responsibility which the position involves, a position which my own consciousness assures me might, with greater benefit and pleasure to you, have been conferred on one of the others about me.

One of the chief causes of gratification which the position gives me is that I am able to offer you all on behalf of the Faculty a hearty welcome back to the halls of your Alma Mater, to assure those of you who are now just entering on the threshold of a life of study that this welcome is more than the formal one of a professor to his class, but is that of friend to friend—to remind you that as fellow-students in a profession which demands such sacrifices of time and self as medicine, we all have the same great object in life.

In no profession, perhaps, is this sense of *camaraderie* so strong as it is in that of medicine, no class of students are so true to each other and to their Alma Mater as medical students, and of no other profession are the members so ready and glad to offer each other assistance, when called upon, as those of the profession to which you aspire. I refer to this, Gentlemen, not in any spirit of self glorification, but that I may the more thoroughly impress upon you the fact that your professors are your best friends, and assure you that if you come to them in time of doubt or trouble, the best fruits of their experience and knowledge will be freely and gladly given to you.

I have to congratulate you, Gentlemen of the first year, on entering McGill University at a period in her history marked by such prosperity as the present. It has been her province in the past to set a high standard in the practical and vital branch of education controlled by this Faculty. This duty has been done in the face of grave doubts and difficulties, and this duty our Faculty is now doing, not without the expenditure of much thought and labour, but thanks to our generous friends, without running that risk of financial failure which deters so many schools from adopting the most advanced methods of teaching, and fixing a high standard for their degree.

To a certain extent the laws of supply and demand apply to medical schools as well as to the price of wheat, and there is a perfectly natural tendency in many men towards a school which will give them a diploma for the least expenditure of time, money, and energy. Many schools have come into existence to meet this demand for a short cut to the degree of Doctor of Medicine. So detrimental to the best interests of the community has this undignified competition for students become in the United States, that it was seriously suggested in a recent report by a Commission of Education that every medical school in the country be required by law to provide forthwith an endowment of not less than three hundred thousand dollars. As Oliver Wendell Holmes wittily remarks: "A school which depends for its existence on the number of its students cannot be expected to commit suicide in order to satisfy an ideal demand for perfection."

I say it is partially true that the demand for medical education obeys laws analogous to those which rule the world of commerce, but this is only partially true. The better class of students, as the history of our own institution proves, will always go where a high standard of excellence is required, justly feeling that only when associated with men seeking the highest class of medical education they will find congenial friends, and meet with opponents for college honours who will compel them to exert their full powers.

But there is another aspect of this question, and that is, that the best medical instruction must necessarily be the most expensive, and the most desirable students are by no means those who can easily afford to pay very high class-fees. Well equipped laboratories, good teaching museums and models, large reference libraries, and above all an able staff of professors and assistants, are the necessary but costly features of a great medical school. Our benefactors have set the excellent example of liberally aiding an already tried institution, instead of launching a new one among the many which are now struggling to float, recognizing the fact that by endowing a good medical school they have advanced the thoroughness of medical education, not only by making that school independent of large or small classes of students, but also by enabling it to provide a larger staff of officers of instruction and well equipped laboratories, without compelling that school to make its class fees almost prohibitory.

Before leaving this subject I may add that there is one feature in connection with these recent donations to which I would like especially to call your attention, for it is the one that will continue to give us the keenest satisfaction, and that is that they were bestowed as unsolicited gifts by those who are accustomed to use their eyes in estimating desert, and that this kindly act signifies a hearty approval on their part of our endeavours to advance the knowledge, train the judgment, and perfect the skill of those entering on the profession of medicine.

And so, Gentlemen, it is with a sense of thankfulness for the past, of satisfaction with the present, and of joyful hope for the future that the Medical Faculty begin the sixty-first year of their services to the profession, welcoming their new

riends, thanking their benefactors, and exchanging with each other, their old students, and the Governors of the University, mutual congratulations and good wishes.

The beginning of a new session, the entrance on a new course of lectures, is always an event of great interest to professors and students. The chief interest attached to this period of the University year is due to the fact that it marks the advent of a new class of students. No introductory lecture, therefore, is worthy of the name that does not contain what might be termed its "Freshman's Corner." Herbert Spencer, according to his cold, logical, and scientific ideas of things, would regard you young gentlemen as social units in an embryonic condition. He correctly points out that all social as well as biological advancement is a progress from the general to the particular, a specialization. As your seniors in medicine know well, all embryos, at a certain period in their existence, are more or less alike, and biologists are not able to tell whether a given specimen embryo, at an early period, will become a sheep or a goat, a monkey or a whale. It is only later, when the limbs appear and the head becomes shaped, and we see how it is to go through the world, that it becomes easy to tell what manner of creature it intends to be. Similarly, as boys we were all more or less alike, and though past the boyhood stage, you, for instance, still possess many general but useless characteristics, which you have in common with young lawyers, curates and business men; but now that you are about to differentiate into physicians and surgeons, you must allow those useless appendages of your mind and character to atrophy and disappear from disuse, and develop, by calling them into special activity, your powers of reason and observation and knowledge of humanity in sickness and in health, in order that you may become adapted in the kind of your intelligence to your future environment; that is, to drop the metaphor, you have deliberately and fully chosen medicine as your profession. The world demands, at any price, men that are absolutely fitted to their position. You should, therefore, cultivate in every detail those qualities of mind, of person, and of manner, that will enable you to fill the place that the world reserves for the great physician. Your curriculum of study will not do all this for you. Much must be acquired by personal observation and thought.

It has been said that we all go through the world backwards. We see clearly the path we have travelled, but what is to come is either absolutely unknown, or indicated only by that shadowy knowledge our experience has given us. When we see others in whom we are interested coming blindly along the way we know so well, the impulse to shout back a warning or two is almost irresistible. Let this be my excuse for inflicting on you a little, a very little, of what is recognized in our profession as advice gratis. I do so entirely from a sense of duty, knowing full well that you will not be long here before you get more advice than you will know what to do with. It will pour in on you from all sides, and it will all bear the stamp of the genuine, disinterested article. I shall make this part of my address very short, as I am in full sympathy with that class of healthy-minded young men to which the great majority of you belong, who think twice before asking advice, and then think again before acting upon it. The first advice is: Do not let anything you hear from me stand you in the place of your own thoughtful observation and enquiry. Think out your own view of the profession honestly, liberally, and truthfully. You are entering a profession; you must, therefore, cultivate perfect freedom of personal judgment, and be conscious of your own responsibility. Your time is short; divide it up economically, and do not waste your odd half hours. Be particularly careful of your health; nothing is worth so much to you as that. Do not fear your examinations; above all, do not cram for them. This stuffing your brain with shapeless masses of unorganized learning is the worst possible preparation for examinations. Do not try to commit your text book by rote. No text book, not even Grey's Anatomy, has any claim to be verbally inspired. Make the thoughts on every page your own, and you will find no trouble about clothing the ideas in words.

I have selected as a topic for this lecture one which, though bearing on my own special department, will, I trust, be of sufficient general interest to justify its discussion on this occasion. The subject which I have taken is "The Place of Chemistry in a Medical Education."

First of all let us examine for a few moments the influence that chemistry and the study of chemistry have had on the development of medicine.

Chemistry took its rise from alchemy. It sprang up among those scientific dreamers of the first centuries of the Christian era, whose guiding star in their search for knowledge was their belief in the transmutation of the baser metals into gold. Their theory of the constitution of matter led them to believe in the existence of a sort of ferment, at the touch of which transmutation would occur. This philosopher's stone was also regarded by many as a panacea for all human ailments; so we find thus early the efforts of a class of men turned towards the discovery of a universal medicine, rather than of inexhaustible lucre. Alchemy, although almost divorced from medicine of the time, indirectly contributed not a little to its advancement. The later alchemists, despairing of finding this magic substance in the mineral kingdom, sought for it in the products of animal life. All parts of the human body were assayed. The philosophy of the period taught them to regard man as an epitome of the universe, a microcosm, and his body as a sort of mysterious agent by which the viler material composing his food was transformed into the nobler thinking individual. They naturally concluded that he must possess within him some great transforming agent, and that substances that remained for a long time in the body must be strongly impregnated with this powerful transmuting substance.

Besides many less important results, this search for the philosopher's stone in the human body led to the discovery and partial isolation of urea, uric acid, phosphoric acid and the element phosphorus, and thus gave us the first facts in physiological chemistry. The history of these fruitless endeavous to find a universal medicine, though, properly speaking, merely the history of a superstition, will always prove interesting to the student of science as a record of the strange phases through which scientific knowledge has passed in the course of its slow development; and also of the difficulties and obstacles against which the human intellect has had to struggle in the past, while seeking a solution of the great problems presented by nature.

Towards the end of the fifteenth century chemistry began to throw off the yoke of alchemy. It was just at this period that independent criticism began to spread, and traditional

beliefs to lose their power. The inductive method of reasoning, gradually forcing itself forward, called into existence the first indications of experimental science. This dawn of a new era in thought, which ushered in both chemistry and medicine, found its most powerful expression in the Reformation itself. Although chemistry did not entirely free itself from the fascinations of the hermetic doctrines until a much later period, another aim came into prominence, which gave it a distinctly scientific character. Medicine and chemistry were to be conjoined in the most intimate manner, for their mutual benefit and advancement. The leading physicians of the period became the chemists; as chemists they discovered new remedies, prepared them carefully, and determined their constitution, while as physicians they tried and explained their physiological and therapeutic action. It is to this interaction of medicine and chemistry that this period in the history of science owes its peculiar characteristics. The result was an enriching of both.

Chemistry passed from the cloisters and private laboratories to the universities—passed gradually from the control of vain dreamers and charlatans to that of a learned, and, for the period, scientific profession. Medicine, on the other hand, received from this union the greatest impetus in its history. Doctors became sceptical regarding the infallibility of the works of Galen and Hippocrates, and began to observe and record for themselves. The spirit of independence induced by laboratory experiment and observation extended to their daily practice, and a more careful study of the symptoms of disease followed. The fundamental object of chemistry then became not to make gold, but to prepare and examine medicines; and the knowledge of chemistry thus acquired led to the doctrine that the healthy human body is but a conjunction of certain chemical matters—a receptacle containing chemicals acting in a fixed way. When these underwent change, illness resulted, and the latter, therefore, could be cured only by means of chemical medicines. The spread of this doctrine resulted in the overthrow of the old school of Galen; but, of course, any successful treatment based on such an hypothesis could only be possible when chemistry had attained a higher development.

However, the important fact remained that medicine was now no longer guided by tradition, but by a scientific hypothesis which took its origin from human observation and experiment. In bringing about this union of chemistry and medicine, which was so mutually helpful, no one effected more than Paracelsus. His true name was Philip Hoehner, but, on entering his medical course, he assumed the rather more pretentious name of Phillipus Aurelius Theophrastus Bombastus Paracelsus von Hohenheim. Although he was a pretentious charlatan, a man of widely extravagant and dissolute habits, yet the force of impact, with which this strange, erratic meteor met the opposition of his time, caused the whole fabric of mediæval medicine to totter on its base. The complete discomfiture, however, of the disciples of traditional medicine was effected chiefly by his successors, von Helmont and Silvius, with whom should also be associated Libavius and Glauber.

The views of Paracelsus and his school are naturally seen to be bristling with ridiculous errors, when examined from the altitude attained by medicine of our own day; yet the progress caused by their introduction was very great. The highest talent of the day was enlisted in the ranks of the medical chemists, to whose work he had given such impetus, and to him we owe the discovery of many facts in treatment and physiology, that have remained true to the present time. He was the first, for instance, to recognize the incorrectness of the doctrine that the heart was the centre of heat. His acute observation first called attention to the connection that exists between gout and urinary calculi. His reputation, however, rests chiefly upon the number and importance of the new remedies which he introduced. He was the first to employ as internal medicine the salts of mercury, lead, and antimony, sulphate of copper, and the various preparations of iron. All this, too, was done at a period when it was not the thing to use chemical medicines (and what greater condemnation, even in our own time, could a new departure in therapeutics receive?) No; the orthodox medicines of that period were of a different type. To give you a faint picture of medicine of the fifteenth century, let me quote a few ideas of the great Galen. The following is taken from a chapter entitled,

"The Head and His Parts," in a book of medicine of the sixteenth century. Galen sayeth: "The head is divided into four parts; in the fore part hath blood the dominion, choler the right side, melancholy in the left side, and flegma beareth rule in the hindermost part." In anatomy and physiology such ideas as these prevailed: The spleen was the centre of wit; the size of the brain increased and decreased with the moon; the function of the liver is the seat of love; the lungs were employed to fan the heart, which, in turn, was the centre of animal heat. Based on such physiology, you will readily understand the scientific necessity for this prescription: "Take the right eye of a frogg, lap it in a piece of russet cloth, hang it about the neck, it cureth the right eye if it be inflamed or bleared; and if the left eye be grieved do the like by the left eye of the said frogg." *Similia similibus curantur.* History repeats itself. We have heard of the homœopathic surgeons in the progressive republic to the south of us. Here we have homœopathic ophthalmology in the fifteenth century.

I have thus dwelt somewhat at length on this period in the history of medicine, on account of the effect which chemical views and knowledge had on the diagnosis and treatment of disease. The solution of the problem sought by these old physicians was, of course, impossible. On the other hand, the attempt to see in every occurrence in the body a process of fermentation and decomposition capable of explanation by means of chemical reactions had this beneficial effect: the doctors became accustomed to the thought that they might expect little from tradition and speculation, and everything from the examination of facts. Medicine owes much to the perception of this circumstance. Its effect lasted long after the absurd hypothesis which gave rise to it had passed away. Afterwards a new school of physicians arose, who regarded disease as the result of mechanical disturbances, such as stagnation of the blood, and, as they expressed it, of stagnation of the contents of the nerves. A violent controversy raged between this new dynamic school and the followers of Glauber and Libalius. The result was a partial defeat of the chemical doctrine of disease; but the inconsistencies and one-sidedness of both of these systems of pathology ultimately led to a blending of the two. Medical chemistry came thus to occupy a

subordinate position, and in the eighteenth century it became pharmacy only. All medical chemistry was taught in the drug shops, and its sole *raison d'être* was the preparation of medicines. Only here and there dotted about Europe were to be found men who had the time, means, and inclination to study for its own sake a science which had fallen into such disrepute.

The influence of Paracelsus was not entirely lost, and the profession of chemistry did not become absolutely disreputable until medicine came to be governed by another new doctrine. This new theory was an outgrowth of the dynamic doctrine of physiology which was originally advanced by Stahl. It was a compromise effected with the Church. This was the doctrine of animism. It ascribed all physiological and pathological change to an unknown and unknowable animal force. This has survived under the name of vital force, or *vis vitæ*.

Now, this acknowledgment on the part of the profession, that they not only do not know, but could never know anything about either the substances of the body or their mode of action, at once suggested that all scientific investigation regarding the cause of disease was superfluous. It was a wretched delay in the progress of medicine, as the result of this compromise was to close for ages that path in medicine which alone leads to discoveries of value, the experimental method, and to re-open the old path of empiricism and tradition. This belief in an inscrutable *vis vitæ* persisted, to the detriment of both medicine and chemistry, until the present century was well in the forties.

It is natural that such a doctrine, if this negation can be called a doctrine, should have prevailed. It is only human. When one does not understand a thing in science, the easiest way out of the difficulty is to give it a good name, and look wise. If the roots of that name are deeply mired in Greek, so much the better. *Vis vitæ* is only Latin, but that is compensated for by the alliteration. The words seem to have been born together, like the Siamese twins, and, as in the case of the latter, no doctor dare cut them asunder.

To the chemists Justus Liebig and Wohler we owe the beginning of the overthrow of this fatalistic doctrine, and to

them may be ascribed the credit of introducing the modern period of medical chemistry. Of the physiology and pathology of the eighteenth century only the knowledge which experience gained, and scientific observation disclosed, has remained in the possession of later times. Not one of the numerous systems of schools based on animism now exercises the slightest weight in modern medicine. The material having been collected, however, the few well-cut stones of experience and observation remain for use when an architect arises who can find a place for each in a symmetrical structure.

The belief in vital force has now almost entirely disappeared. We know now that the same chemical laws govern the animate and inanimate worlds, and that definite compounds formed in plants and animals can be prepared artificially, as soon as their chemical constitution has been worked out. The conditions under which the constituents of the body are produced we can only conjecture, but that they obey laws different from those which rule the inanimate world is a view which is no longer tenable.

After this rather long historical sketch of the progress of chemistry and medicine, and the objections made to the theory of animism, it is but natural that you should expect me to maintain the thesis that the chemistry and physics of to-day are able to suggest a theoretical foundation for the art of medicine—to indicate a sort of mental *résumé* for all departments of the healing art. Such a brief description, or formulæ resuming all medicine chemistry has not found and may never find; but of this you may be sure, that its method of seeking for one is the sole possible method, and that the truth reached by this method is that which will most permanently satisfy the human judgment. You would misunderstand me if you imagined that I think it even possible that the psychical and biological enigmas underlying physiology and pathology can be elucidated in the chemical laboratory. That this can ever be done we have at present no evidence whatever. The gateway to the acquisition of a theory of medicine that will harmonize our past with our possible future knowledge is the experimental method of investigation—a method which is employed by chemistry, which was introduced into medicine, taught and especially illustrated by chemistry, and for the

advancement of medicine must be applied, not only to chemical research, but to biological and psychical research as well. Chemistry got beyond its depth when it undertook to analyze the complicated processes of life into their several factors, and to explain them in accordance with the rigid laws of chemical action, and the lesson taught has not been forgotten.

The goal of chemistry as an experimental science is to offer a complete interpretation of the constitution of everything animate and inanimate; but the goal is an ideal one. It marks the direction in which we travel, but never the spot we shall ever actually attain. For, as the late Kingdon Clifford says, "Scientific thought is not an accompaniment or condition of human progress, but human progress itself."

I have now tried to show that the history of medicine, as a whole, shows progress or stagnation in proportion as the experimental method of enquiry, the process of trying and thinking, has been used or neglected, and that this method is the one that will most surely sift facts from fancy, and, by the orderly arrangement of facts, enable us to see relations previously obscured. I now wish to emphasize the fact that a training in this method is of the highest importance to every student of medicine. You, as students, are not now so intimately concerned with the advancement of science as with the acquisition of the knowledge and training that will make you useful practitioners. "How, then," you may ask, "will a training in the experimental method of enquiry be of such advantage to us? Very few of us will be placed in circumstances that will enable us to become investigators; what we want are useful facts; we wish to be practical men, practitioners." Now, that is precisely what we intend to help you to become; investigators you may be some day, but you must acquire your profession first. It is obviously impossible to advance medicine until one has mastered it; he must first step to the front before his blows can tell in the strife, and I may add—I do not believe anyone can be thorough in any department of science without wishing to advance it. But I will tell you why this training is of such importance: because it educates your seeing powers—your mental vision. It teaches you to observe correctly, and to reason accurately from your observations. That you should receive a training

in this method is almost an essential to success, and it is the surest way of enabling you to assimilate and made part of yourself the very facts you feel are indispensable for your profession. I need scarcely remind you that the whole practice of medicine consists largely in the exercise of the power of observation. To make a correct diagnosis requires this power to be acute and highly trained, or some imperfectly developed symptom may escape recognition, and your own experience teaches you what a very difficult thing it is to observe correctly; to see everything, even in a small field of observation; to proceed methodically, overcome the desire to flit from one object to another; and to exclude what you wish to see, what you were told to look for, from what is actually there.

A training in experimental work also aids you in acquiring the facts of science, in learning your profession, not only because it educates your attention and precision of observation, but especially because it teaches you to question nature, to cross-examine her and yourselves as well. Cultivate, then, Gentlemen, early in your career, the habit of careful observation, and go to nature herself for information, whenever you have an opportunity. It is the pride of this Faculty that she has always insisted upon laboratory work as an essential portion of the preliminary training of her students, and that the chief portion of the final work is taught with a patient before you, at the bedside in the hospitals. But before you reach this later stage, you should have acquired the habit of mind which only the experimental sciences can give you. Now, chemistry, of all your primary work, presents you with the best examples of accurate and discriminative observation and of inference therefrom. It begins with the study of the simplest phenomena, and advances the investigation step by step to a complete and exhaustive analysis of complicated relations. You will never, however, acquire a scientific training from a mere literary acquaintance with chemical facts and theories. In this way you acquire only scientific information, an altogether different thing. You must seek out the information for yourselves, and obtain your knowledge of chemical facts at first hand, by making the best use of your time in the laboratory; and, believe me, if you do not train yourselves to observe and think for yourselves when the objects you have to

examine are comparatively simple, when the complex phenomena of disease in its many forms are presented to you, you will find that you cannot or will not do so, but will be guided by empiricism, or by what the text-book or lecturer says should be seen; and as the student is, so is the practitioner.

Lest you should think I am over-estimating the value of laboratory work in chemistry as a training for the profession of medicine, I will give a few reasons for the faith I have in its power of developing the scientific habit of thought. But first let me offer a word of explanation. I do not in the least under-estimate the training afforded by the other two great primary subjects, anatomy and physiology. They are, when properly studied, of very high educational value; but still, their greatest utility is in the intrinsic value of the subject matter taught. Every fact of these branches has a direct bearing on medicine and surgery. Anatomy, besides, is an excellent training for the memory, and also cultivates the observation, but not the same sort of observation that is developed by experimental science. You learn anatomy in precisely the same way that a cabman learns the streets and principal buildings of the city, by going over the ground again and again, till the relation of nerve, artery, and vein are as familiar to you as that of sidewalk, curbstone, and pavement to the city carter. It is only in this way you can learn anatomy. You must see the relative position of parts, and see them again and again, and from all sides, before you can find your way with certainty about the human body. You would be as much justified in undertaking to drive a London Hansom cab because you had made a study of Baedeker's Guide Book, as you would to enter the field of surgery without years of training in the dissecting room. Observation, and careful observation, is required and developed by anatomy, but not that which involves casual relations. Remember, I am speaking of human anatomy, not of general morphology, nor of comparative anatomy. In human anatomy, observation is not associated with reasoning as to the relation between one fact and another. There is no mental effort, such as tracing an observation back to the grounds of belief in its truth, and forward again to some other observation for discovery or verification. Such processes of thought are required, however, in

physiology; but experiments in this department are made with difficulty. The material and the forces are so complex, and altogether so little is actually known, and so much conjectured, that verification even of the simpler phenomena is difficult and uncertain, and requires much time and elaborate apparatus.

The problems of animal physiology, except those which are of a chemical nature, are far too difficult to serve as a means of scientific training for beginners in medicine, and should really be undertaken only after one has received a good laboratory course in chemistry.

Now, I have no intention of forcing you to select chemistry as the subject affording this most desirable training, by any process of exclusion. On the contrary, I wish to point out clearly, how by work in chemistry you may derive that scientific training which I have tried to show is essential for the successful study and practice of our profession. In the first place, lectures on chemistry, even when illustrated by experiment, are of comparatively small value as a means of training. Lectures are, of course, essential to expound the relations and theories of the science, and to illustrate them by experiments which are not adapted for a teaching laboratory; but it is by practical work only that a student can extract the full benefit obtainable from an experimental science such as chemistry. As Huxley says, "The laboratory is the fore-court of the temple of philosophy, and whosoever has not offered sacrifice and undergone purification there, has little chance of admission into the sanctuary."

One of the first surprises that a student of practical chemistry receives is to find out what a very difficult thing it is to do what you are told to do—to find out what little power mere words have to create a correct picture in the mind. This is due to the fact that to those untutored in scientific observation there seems to be scarcely any connection between words and the things represented by them, except in the case of affairs of every-day life. Now, this power of clearly picturing before your mental vision a sequence of things from a verbal description is a function of the brain called the scientific imagination, a power latent in all minds, and one which, unless developed by a training in scientific work, is likely to remain dormant throughout life.

Develop, then, this mental faculty at every opportunity by endeavouring to create before your mental vision a distinct image of the thing described—a picture of the reality. The power thus acquired will help you in every walk of life.

I have already dwelt on the importance of observation, and correct reasoning on the facts observed. In chemistry a student is brought face to face with nature, and with that field of nature which is capable of very accurate examination. He learns of her by reading and by experiment, and the juxtaposition of the two necessitates thought. He handles and sees the things he reads about, hence he gets definite ideas of things. He performs a certain experiment with a certain result—a result always the same, under the same conditions. The experiment is simple, the conditions easily controlled, and the result sure. This leads him to ask the cause of this inevitable result. What are the relations of the materials entering into the re-action—what the product? He has questioned nature and received a reply; he now questions himself, and the very asking the question causes thought. He creates a theory, or applies one he learns elsewhere, and verifies it by further experiment. The whole process is, necessarily, when properly taught, an alternation of observation and thinking; and he must observe correctly, and think correctly, or his error will certainly find him out. The punishment for error in chemistry is quick and certain, if the student only works with care. It is just in this particular that chemical work affords the most valuable training for a medical student—his little mistakes are never productive of erroneous ideas; because from the very nature of the work he must, sooner or later, detect his own error, when the work has to be done over again. This self inflicted punishment for error occurs again and again in a day's work. The little blows thus inflicted do not discourage, but tend to shape the mind, until constant watchfulness, accuracy of observation, and a determination to reach absolute truth in his work become a habit of life, a part of his very nature.

I might suggest to you, Gentlemen, many means of helping yourselves to cultivate this habit of close attention and accurate deduction; but I will refer to only one, the great value of which experience has shown me is not as fully appreciated by

you as it should be. What I refer to is the habit of carefully recording all your observations when directly in contact with Nature, and also all the chief facts connected with them. Do not trust to your memory, for you may forget an important detail, or, worse, it may return to you a disturted image of the original, an image that has been gradually altered in the process of keeping.

Gentlemen of the first year, begin this practice at once with the objects presented to you in botany and histology. Make rough sketches of some of your dissections, even if you destroy them immediately after. In the chemical laboratory it is absolutely essential to progress to record everything that happens—your reasons for the experiment, and the conclusions deduced from it. Make notes of what you see and do in the physiological laboratory; what you see at the bedsides and at the autopsies. It should be the constant habit, not only of your student life, but after you leave us to engage in practice; and especially remember that these notes are always to be made with the object you describe before you. Now, if you have any doubt regarding the importance of this habit, convince yourselves of its value by trying this experiment on yourself. Make a simple series of re-actions on a substance in the laboratory, or examine carefully a plant or a diseased organ, and afterwards, in the quiet of your own room, sit down and write out what you did and what you saw; and unless you are more than ordinarily gifted, I feel sure a comparison of your notes with the original, next day, will convince you of the fact that to delineate *ad Naturam* your model must be always before you.

Much more might be added regarding the educational value of laboratory work in chemistry, but I will content myself with pointing out, in conclusion, that although other subjects, notably practical physics, are able to afford much the same sort of education, yet in none are the materials so available and of such constant properties, or the apparatus so inexpensive and simple, or the experiments so easily made, and the results so quickly obtained as in chemistry.

The tendency of education to-day, in all branches, from the kindergarten to the university, is more and more towards placing laboratory work und personal observation before tra-

dition and theoretical instruction, and we hope, in the near future, when this wave of progress is felt by those who regulate our medical curriculum, to be able largely to increase the valuable laboratory work in chemistry, and in greater proportion to reduce didactic lectures. This change, however, can be effected only when a higher quality of chemical work is done in medical schools than is now possible. We are bound to our present system of teaching by two forces—the standard fixed by the licensing boards, and the absence of preliminary training in science on the part of the great majority of our matriculants. Higher chemistry should be taught in our medical schools, and much less of it. It is positively cruel to require a medical student in his first year, whose time is so fully required for those things which bear directly on his future work, to go through the drudgery of mastering the elements of chemistry. To obtain a knowledge of chemical nomenclature, and the nature of chemical processes, is not very interesting, and is hard work; and to do even this thoroughly certainly occupies for him one of the two precious years he has at his disposal for the preliminary studies, and in his second year but little time is left for either acquiring a knowledge of medical technical chemistry, or for the training which laboratory work affords him. It is not doing justice to chemistry, nor to the professors who teach it, that this condition of affairs should exist. The student naturally regards chemistry, up to within a few months of the end of his study of it, as something uncanny, made up of barbarous names and very crawly formulæ—as a science presenting all the difficulties of algebra, without its compensating accuracy. It is only too late when he finds out that formulæ and nomenclature are not chemistry, but bear about the same relation to it that the German irregular verbs bear to the poetry of Goethe's Faust.

The remedy for this is obvious—he should be required to know the elements of chemistry before entering medicine. The only chemistry taught in medical schools should be organic and technical medical chemistry, or what the late Dr. Carnelley has called bio-chemistry, which, as the name suggests, is the science which treats of chemistry in relation to life and its attendant phenomena. It treats in brief of the action of dead matter on life, and the reciprocal action of life

on dead matter; and, of course, includes what is usually called physiological, pathological, and sanitary chemistry. All the training which chemistry can afford in the experimental method of inquiry could be given in a chemical laboratory by experiments in medical chemistry, as well as, if not better than by using our present system. In fact, any portion of the field of chemistry does almost equally well as a training ground. In the course given here, the re-actions of the common acids and metals are used for this purpose, not because the information obtained is of value to medical students in particular, nor because that portion of the field of chemistry affords any better subject matter for experiment, but because it is as good a field as any other, and it is a very favourite hunting ground of the Board Examiners.

Apart from laboratory training, what every medical man requires is a clear view of the broad principles of chemistry, that he may intelligently follow advances in medicine made by chemical research, and a limited acquaintance only with the facts of chemistry. A knowledge of two classes of facts is required: first, those which are essential to a perfect understanding of the principles of the science, very few in number, and second, those which bear directly on his profession. It is the first class of facts that should be partially acquired before entering medicine, in order to give both professor and pupil time to dwell on the more congenial, important, and interesting facts that bear directly on the principles of the healing art.

Apart from its value as a means of training the student in those habits of thought especially useful to him in his profession, chemistry has another claim to a high position in a modern medical education—a claim based on what she has shown herself able to do in aiding physiology and pathology in the solution of the fundamental problems of medicine.

Time will not permit me to discuss even the more important advances recently made, and a mere enumeration of the results obtained would be tedious in the extreme. I shall have said enough on this subject when I remind you that although the great powers of the chemical and physical sciences to aid medicine have only recently been appreciated, these sciences, and especially chemistry proper, have shown

the existence of fields of research of unimagined fertility. The whole of preventative medicine, the medicine of the next century, is becoming more and more a chemical question.

Bio-chemistry has taken up the thread of research, where it has been lost to the highest powers of the microscope. There is no field of science which during the past few years has attracted the same public attention as that which is now being searched over by bio-chemistry and pathology. As I have hinted elsewhere, recent synthetical work has about completed the rout of those who believe that the higher products of life, the more complex of the constituents of plants and animals cannot be fabricated from their elements by artificial means.

The recent synthesis of grape sugar by Fischer and his pupils, and the synthesis from their proximate principles of too proteic substances by Schutzenberger, exhibiting the chemical and physical properties of peptone, show that the chemist can construct even the most characteristic compounds and the highest products of life. The construction of a starch granule or a muscle fibre, however, will always necessarily remain beyond his powers. It is as absurd as to expect the chemist to synthesize organized tissue as to expect that a workman who could combine copper and zinc to make brass could construct a modern chronometer. But the problem of synthesizing the different materials of which the living cell is composed is to the chemist of to-day a far easier problem than the construction of a telephone would have been to the electricians of the time of Volta or Ampére.

The greatest value of the contributions made by chemistry to our knowledge of disease is not so much the actual benefits they have conferred on medicine as the clear prophecy they utter of greater blessings to come. The study of medicine is carried on amidst the deepest mysteries of nature. We have been created with minds to enjoy, and reason to aid us in unfolding such mysteries. Nature calls us to study her, and all our better feelings urge us in the same direction; and, Gentlemen, I shall have missed the object of this lecture if I have failed to impress you to some extent not only with the necessity of studying Nature, but of obtaining your knowledge

of her at first hand. Agassiz has said, "If you study Nature in books, when you go out of doors you cannot find her;" so if you study disease only in lectures and text-books, when you go to the bedside you will not recognize it. Remember that the physician is a servant of Nature, never her master, and he only will rise in the service who can follow close in her footsteps, and successfully aid her in her struggle with disease.