An Address

ON

THE SCIENCE OF CLINICAL MEDICINE.

GIVEN AT THE WESTMINSTER HOSPITAL, OCTOBER 1ST, 1926,
BYSIR ARCHIBALD GARROD, K.C.M.G., D.M.,
LL.D., F.R.S.,REGIUS PROFESSOR OF MEDICINE IN THE UNIVERSITY OF OXFORD;
CONSULTING PHYSICIAN TO ST. BARTHOLOMEW'S HOSPITAL
AND TO THE HOSPITAL FOR SICK CHILDREN, LONDON.

A VOYAGE down the Thames from its upper reaches to London gives a mental picture of the river, and of its significance, wholly different from that obtained by looking at it from the Tower Bridge. So also it seemed to me, when I was asked to speak to you on this opening day of a new session, that one who has lived through such a period of unrivalled progress in medicine and surgery as the last half-century should have a message to deliver to those who see before them the fruits of that progress, but only as accomplished facts.

It is obvious that the medicine which you are learning to-day is very different from the medicine which we set out to learn fifty years ago. In the interval the work of the bacteriologist and protozoologist has changed our conceptions of the nature of disease, and has revealed exquisite mechanisms by which the organism protects itself against the assaults of the agents of disease. The Listerian methods have revolutionized surgery, and have widened its scope immensely. By combating the insect carriers of those maladies vast tracts have been freed from malaria and yellow fever. From the biochemical side also there have been great advances, and terms such as "hormone" and "vitamin," which embody conceptions of which we in our student days had no inkling, have become household words.

New and far more delicate methods of diagnosis have been devised; the range of therapeutic measures has been greatly widened; and even dietetics is being placed upon a scientific footing.

All this has entailed profound changes in the curriculum, and has added much to what you have to learn. Even the longer curriculum is becoming seriously overladen, and the student's burden is causing much concern to his teachers, who look round to see what can be jettisoned. The student himself, I am bound to say, appears much less perturbed thereby.

But not only is the subject which you study, and the curriculum laid down for you, greatly changed; you yourselves have a very different outlook from that of the students of the past. The change of ideals and standards of the student of to-day—the schoolboy of the war time—is not easy to define in words, but is very evident to those engaged in teaching in our schools and universities.

DEMANDS ON THE MEDICAL STUDENT.

I would begin by pointing out to those of you who are just entering upon a medical career that two separate demands are made upon you. The first is that you shall acquire a working knowledge of the sciences upon which medicine—and I use the word in its widest sense—rests. You need to study at the bedside and in the laboratories the signs and symptoms of maladies; to acquire the technique of the therapeutic measures at our disposal, and to become skilled in their application. Without such knowledge and skill no man can expect to practise our profession to any good purpose; and to impart them is the function of the medical school. The student learns from his teachers at the bedside, from lectures and demonstrations; from practical experience under guidance, and from his fellow students. Lastly, what may be called the atmosphere of his school, that mass of floating knowledge which forms its tradition, and is handed down from generation to generation of teachers and students, plays no small part in his education.

But, apart from his professional competence, the medical man, who is brought into peculiarly intimate contact with his fellow men, must have other qualifications for his task.

He needs to be equipped with tact, resourcefulness, courage, and prudence. He must have patience with fads, consideration for his patients and their friends, sympathy with suffering, and gentleness of touch and voice. Much indeed is asked of him, but without these qualities, be he never so able, he will make but a poor practitioner. Of this side of the medical profession I do not propose to speak further, seeing that its scientific side is my theme to-day; but I am anxious to emphasize, at the outset, the importance of the human aspects, which each student must learn for himself, aided by the example of his elders.

FIFTY YEARS AGO AND NOW.

The student of fifty years ago almost always entered upon his studies with the intention of taking up some branch of practice, or of entering one of the public services. Few alternatives were open to him. There were no bacteriologists, pathology was synonymous with morbid anatomy, and the men who, from the end of the eighteenth century onward, had laid the foundations of biochemistry in this country were all practising physicians. They, and others of scientific bent, pursued their researches in the period of waiting for practice and in its intervals, but nevertheless they were pioneers, not only of the medical, but of other sciences also.

Nowadays the position is very different. In addition to the physiologists, most of whom still go through the medical curriculum, not a few qualified men turn aside from the path of practice and devote their lives to teaching and research in the various branches of pathology or in pharmacology.

This has its advantages and its disadvantages. On the one hand, some men of scientific tastes and interests—for whom the work of the laboratory has great attractions, whereas the practice of medicine has none—enter the profession, and by their researches contribute greatly to the advance of our science and art. In that way medicine is the gainer. But, on the other hand, there is real danger that the great majority of men of scientific bent will turn aside and desert clinical work, in order to devote themselves to work in the laboratory. This tendency is increased by the attitude of some of the laboratory workers, who regard clinical medicine as a subject hardly worthy to attract men of scientific ability. So there has been a drift apart of the ward and the laboratory, which is far more pronounced in this country than elsewhere, since it is only recently that complete clinical units, with wards and laboratories under a single head, with trained assistants, have been established amongst us.

THE SCIENTIFIC SPIRIT AND CLINICAL MEDICINE.

It will be my endeavour to convince you that there is abundance of work to be done on clinical subjects by strictly scientific methods; and seeing that much of the information to be sought can only be got by clinical research, it would be nothing short of a disaster if all, or nearly all, those qualified by tastes, training, and opportunities to pursue clinical investigations on such lines should desert the wards for the laboratories.

The study of pure pathology and of the problems of immunity entails experimental investigations by men highly trained in the subjects and the methods employed, in bacteriological technique, and chemical manipulation; and those who devote their lives to such work are most valuable members of the profession. But, on the other hand, the mere fact that a piece of work is done in a laboratory does not make it a scientific research; and the routine of clinical pathology is not more scientific than the examination of a chest, the diagnosis of a lesion of the brain, nor even than the careful taking of notes at the bedside.

It is not to be expected that everyone who enters upon the practice of medicine will approach his work in a strictly scientific spirit, and with zeal to contribute to the advancement of knowledge, although he must employ scientific methods. It must needs be that the bulk of the members of our calling will, owing to the incessant demands upon them, have little time or opportunity for investigation on broad lines. They must be content, willy-nilly, to carry out the day's work with practical skill and

common sense, making good use of what they have learnt from their teachers and from their own experience. Yet not a few of those so circumstanced make important contributions to medical knowledge.

On the other hand, it must not be forgotten that the knowledge upon which the art of medicine is based has been gained by work done on scientific lines, by methods of observation and experiment. All the great therapeutic advances of recent times have been the outcome of scientific investigation; and in medicine, as in other sciences, investigations carried out with no practical aim have proved very fruitful in practical results. It is to scientific research that we owe aseptic surgery and all that it has rendered possible, the conquest of insect-borne diseases, the banishment of the typhoid terror from campaigns, the discovery of the vitamins, and the utilization of hormones. No better example can be quoted than the history of insulin, from the experiments upon dogs of von Mehring and Minkowski to its widespread benefits in the present day.

Now that the curriculum is becoming so crowded there is being put forward a view that in the medical training unnecessary stress is being laid upon the earlier stages, and that the student learns much more than he needs of the details of anatomy, and even of physiology. Believe me, this is a dangerous doctrine. Anyone engaged in clinical teaching knows that the clinical clerk or dresser who has been well trained in those subjects has a quite different grasp of medicine or surgery from that of a student who has only acquired the minimal amount of knowledge needful. However good a practitioner he may make, the man whose knowledge of physiology is slight is little likely to advance the science of medicine; for pathology is anatomy and physiology gone wrong.

I know well that there is a limit to what a student can do in the time allowed, but in building a house it is a bad plan to skip the foundations. Given solid foundations the upper stories may be added at discretion. The great majority of us learn what anatomy and physiology we acquire during our student days, but medicine and surgery we are teaching ourselves each day of our active lives.

BRANCHES OF CLINICAL SCIENCE.

The science of clinical medicine has several distinct branches, in which different means are employed and different results are aimed at, and these it will be desirable to consider in turn.

In the first place, the clinician seeks to know the nature and seat of the patient's illness, and without such a diagnosis his treatment must needs be perfunctory. His next aim is to do what he can for the relief of the patient's symptoms, and, if possible, for the arrest of his malady. These are the direct and immediate aims of the practitioner, but behind and beyond them is the study of disease, as it manifests itself in the living human subject, the gaining of new knowledge, the advancement of our science and enlargement of our art.

THE SCIENCE OF DIAGNOSIS.

The science of diagnosis is, in the main, a science of observation, the aim of which is to detect in the living patient processes and lesions which are beyond our reach, but which would, in most instances, be revealed at a *post-mortem* examination. Yet it rests largely upon *post-mortem* teachings, and all who aim at becoming capable diagnosticians should take advantage of every opportunity afforded to them of seeing, and whenever possible conducting, such examinations. Such opportunities are most common during student days, and only too many of us regret in after life the neglect of such opportunities; for morbid anatomy, one of the most important subjects in the medical curriculum, can only be learnt by personal observation. Do not forget that there is an immense difference between facts which we *know* and facts with which we are merely acquainted. Facts which we know are not those about which we have read, or have heard in lectures, but those which we have observed, apprehended, and confirmed for ourselves. We need no *memoria technica* to recall a fact which we *know*.

Some diagnostic methods are simple and involve merely

the use of our senses—of our eyes, ears, nose, and fingers; others require the use of instruments of more or less complexity; and others, again, involve chemical or bacteriological examination of the blood or excreta, by methods usually carried out in the laboratory. It is hard to realize how recent most of our diagnostic methods are. Auscultation and percussion were only brought into use at the end of the eighteenth century; the clinical thermometer came into general use in our hospitals as recently as the seventies of last century. Blood counts began in the same decade, and the importance of leucocyte counts was only recognized in the nineties. Since then our diagnostic resources have been largely increased. The discovery of the tubercle bacillus, and its ready detection in the sputum of many sufferers from pulmonary tuberculosis, opened the way for wide applications of clinical bacteriology—the detection of various bacteria on the one hand, and the agglutination tests on the other. More elaborate means, such as the Roentgen rays and the electrocardiograph, have rendered our findings far more precise, and we now have methods of testing the functional efficiency of such organs as the liver, kidney, and pancreas.

As long ago as the middle of the last century uric acid was detected, and estimated, in the blood of the gouty, but in recent years methods have been devised which render possible the estimation, not only of uric acid, but also of glucose and urea, in a few cubic centimetres of blood.

All these refinements and advances have not superseded the older and simpler methods. It is as necessary as it ever was that the medical man shall be trained to make use of all his senses, supplemented by the stethoscope and thermometer. A laboratory is not always within reach, and it is often necessary to act before a bacteriological report can be had. Moreover, the older methods have been improved, and pulmonary tuberculosis is now usually diagnosed by auscultation and percussion at a stage at which it would have escaped recognition fifty years ago.

Auscultation and percussion are strictly scientific methods. Consider for a moment how by such means it is possible in very many instances to ascertain beyond all doubt that a patient's lung is consolidated, or that his pleural cavity contains fluid; that his heart is hypertrophied or dilated, or that there is narrowing of a valvular orifice or leaking of a valve. Such diagnoses involve accurate observation and sound interpretation of the signs observed, and the confidence with which we make them is due to confirmation of such diagnoses at many *post-mortem* examinations.

Lesions of the nervous system often present difficult problems of localization, for the brain and spinal cord are wholly out of reach of direct examination. Yet by making use of the findings of experimental physiology, and the teachings of morbid anatomy, it is usually possible to make a correct diagnosis of the seat and nature of a cerebral or spinal lesion—just as a man who is thoroughly conversant with the telephone system may, by comparison of observations made in several branch offices, diagnose accurately the place, and form a shrewd notion of the cause, of an interruption in a central office which he cannot visit.

A diagnosis often involves replies to two questions—namely, Where is the lesion? and What is its nature?—but the answers often hang together. For example, the signs and symptoms, in a particular case, point to a lesion of the head of the pancreas, and experience teaches that such a lesion is almost certainly a carcinoma. Yet a diagnosis may be right in one respect and wrong in the other.

There are some people who possess a natural diagnostic insight, and others who acquire such an insight by long experience. The accumulated impressions, derived from cases seen at various times, may point to a right solution. Just as a child spells out the letters of words, and a beginner translates laboriously what he reads in a foreign tongue, so the medical student runs over in his mind the possible causes of an observed sign or symptom. But experience allows such conscious effort to be dispensed with, the foreign words come to convey their meaning directly, the clinical picture suggests a correct diagnosis.

One of the dangers which beset the medical student of to-day is that he may be tempted to neglect that thorough grounding in auscultation and percussion and the simpler

chemical and microscopic tests which can be made at the bedside, and may come to rely upon reports from the laboratory of examinations which he has not himself carried out. To this danger all examiners in medicine and surgery are keenly alive.

SCIENTIFIC THERAPY.

The treatment of disease, also, is developing along scientific lines, and in no part of the field of medicine has more conspicuous progress been made during the last fifty years. The advances of surgery, which have been rendered possible by Lister's researches, are obvious and generally recognized. It is the privilege of the surgeon to obtain more definite results; he removes the inflamed appendix and the danger to the patient is at an end; by the sacrifice of a limb the whole body may be saved. The physician, on the other hand, has usually to help the patient to hold his own whilst Nature works a cure. It is one of the most important lessons learned during the last half-century that the physician is not the protagonist in the fight with disease, and the patient's body the battlefield, but that Nature has provided the patient with power to produce drugs far more potent than any which we were wont to use, and so discriminating that they can destroy the particular attacking bacteria or neutralize the toxic substances which they produce. The extensive use of sera and vaccines in the present day represents our attempts to utilize Nature's own remedies; and we may hope that, in due course, we shall be able to give them as pure products, free from undesirable admixtures.

Many of the old drugs, introduced at the dictates of fantastic theories, of astrology or of magic, are falling into disuse, and others, of proved value, are being investigated on pharmacological lines, and their mode of action and the limits of their utility are being determined. But we are bound to admit that amongst the old drugs, introduced on no scientific grounds, there are not a few which are of great value, and have for centuries contributed greatly to the healing of the peoples. Now that we know better how and when to use them their utility is greater still.

Dietetics, for long the most backward and empirical branch of medical treatment, is coming within the scope of scientific therapeutics. The discovery of the vitamins, and the appreciation of the importance of calorie value of foods, are signs of the times, but we still give advice on diet for which we can give no scientific reasons and the utility of which rests upon no firm basis of experience.

The advance of science is furnishing us with new methods of treatment, with most of which we are still feeling our way. I need only to mention Roentgen rays, radium and its emanations, light and ultra-violet rays, the recent developments of electrical treatment, of massage and manipulative measures. Lastly, a tribute must be paid to the nursing methods of the present day, which strengthen our hands so greatly in the fight against disease.

THE PURSUIT OF CLINICAL RESEARCH.

So far I have spoken of scientific knowledge and method, as applied to the recognition, control, and treatment of disease, but what I particularly wish to emphasize is the fact that the clinical observer has abundant opportunities for the study of disease as seen in the human subject—in other words, for the pursuit of clinical research. Much of the knowledge so obtained is not to be had from experiments on animals; for a human patient can describe his sensations with greater or less accuracy, and can tell us of the medical history of himself and his family. Such work as that on the sensory nerves which we associate with the name of that great observer Henry Head could not be done in any other way.

Although it is established that, in the majority of instances, illness results from the invasion of the body by micro-organisms, vegetable or animal, or by poisons of inorganic origin, and although such immense help has been got from the culture and study of such organisms and of their effects upon lower animals, and by the experimental study of the phenomena of immunity, we cannot learn in the laboratory all that we need to know about disease.

What we call disease is the response of the organism to

the invasion of the agents of disease, and, seeing that no two individuals are exactly alike either in structure or in chemistry, sickness does not conform to any single model; each individual case calls for careful observation. Owing, as I believe, to their chemical individuality different human beings differ widely in their liability to individual maladies, and to some extent in the signs and symptoms which they exhibit. Hence it will be found a useful maxim that there is no such word as "never" in medicine. Rules which appear to be immutable turn out to have their exceptions.

Many idiosyncrasies are obvious and notorious, such as the sensitivity of individuals to special drugs, or particular articles of diet, which have no ill effects upon others. As examples may be quoted the manifestations of sensitivity to proteins, seen in the various forms of urticaria, in hay fever, and in varieties of asthma. Light also is an agent which affects various individuals in very different ways. Usually beneficent, it produces unpleasant effects upon the skin of some individuals, and to a very few who are victims of congenital porphyria it is a veritable poison.

Again, the minor injuries which are necessary accidents of the wear and tear of life vary greatly in their effects. In the bleeder a trifling knock may produce grave trouble in a joint; in victims of that strange anomaly fragilitas ossium it may cause a fracture; in a gouty subject it may induce an attack. So do our idiosyncrasies and our circumstances contribute to the moulding of our maladies. All this is the true basis of the doctrine of diatheses now unduly neglected.

PIONEERS IN CLINICAL RESEARCH.

It is by clinical observation, controlled by morbid anatomy, that almost all the maladies with which we are familiar have been differentiated. By the study of groups of allied cases, of the signs and symptoms met with during life, and of the lesions found after death in fatal cases, the door has sometimes been opened to wide extensions of physiological and pathological knowledge.

One of Nature's experiments, the placing of a lesion in some particular spot, may serve to reveal the functions of the part affected. Let me illustrate this point by a particular instance.

In the year 1855 Thomas Addison, one of the greatest clinical observers which this country has produced, published a description of *The Constitutional and Local Effects of Disease of the Suprarenal Capsules*. In the preface to his pamphlet—one of the classics of medical literature—after pointing out that the pathologist may sometimes be able to throw much light upon the functions of diseased organs, and that we are apt to forget how much of our physiological knowledge has been revealed by casual observations of the effects of disease, he goes on to speak of the adrenals, and adds: "It is as a first and feeble step towards inquiry into the functions and influence of these organs, suggested by pathology, that I now put forth the following pages." Yet that "feeble step" was destined to be epoch-making; for Addison's description of the disease which goes by his name was the starting-point of our present knowledge of the functions of the endocrine glands; and the recognition of the hormonal action of their secretions, and of their mutual interdependence, constitutes one of the most conspicuous advances of physiology and pathology during the last half-century.

It is true that the malady which we call exophthalmic goitre was described by Caleb Parry, Graves, and Basedow at a much earlier date. Those observers recognized the association of the cardiac and ocular symptoms with enlargement of the thyroid gland, but it was not until much later that it was realized that the affection of that gland was the pivot of the clinical picture, and that to derangement of its functions the other phenomena were due.

Since Addison's day clinical observation has continued to play a conspicuous part in this field of pathology, as witness Gull's work on myxoedema, the highly original researches of Brown-Séquard, the recognition of acromegaly by Marie, and of its antithesis by Fröhlich, and the surgical labours of Harvey Cushing and others.

Let us pause, then, to consider how Addison set to work. He noticed that a certain group of symptoms was apt to occur in association—namely, anaemia, debility, remarkable feebleness of the heart's

action, irritability of the stomach, and a peculiar dingy or smoky discoloration of the skin—and that in every case in which this syndrome was met with extensive disease of the adrenals was found *post mortem*. So constant was this association that, in the later cases of the series, the disease of the adrenals was predicted during the lifetime of the sufferer. Addison's disease is decidedly uncommon, but, as it is uniformly fatal, he was in a position to verify his conclusions in the majority of the cases.

For my next example I will go to the remarkable series of papers by William Jenner on the differentiation of typhoid and typhus fevers, in which also we may admire the workings of a great clinical talent. Jenner's conclusions were based upon a series of sixty-six fatal cases of continued fever, all of which had come under his own observations in the London Fever Hospital, and in all of which autopsies had been made. The first of these papers was published in 1849, and at that time, although various observers, in this country and abroad, had maintained that typhoid and typhus fevers were specifically distinct, the trend of current opinion was towards their inclusion as varieties of the same disease. To quote his own words, Jenner

"considered that it was necessary to begin *de novo*, and consult only the voice of Nature—convinced that although the most intellectual might fail at first to comprehend her often ambiguous language, yet her most humble votaries might, by patience and daily watching, by keeping honest record of every sound she uttered—by joining letter to letter, adding word to word and line to line—at last spell out her meaning, and so reach that rank which the great master of induction tells us man may legitimately hope to attain—namely, that of her interpreter."

This is the true scientific spirit, and following its guidance Jenner was able to settle the point at issue once and for all, on evidence which carried conviction.

He investigated the place of origin, age, and circumstances of each patient in his series, collated the observations relating to each symptom in turn, and showed that the outcome of clinical observation accorded with that of *post-mortem* examinations, and that from the character of the rash alone it was possible to predict the presence or absence of intestinal lesions.

Jenner's monograph is one of the foundation stones of the statistical method in medicine, which he defended warmly against those who prefer to rely upon general impressions. "Who," he asks, "can tell what general statements are worth, without knowing on what evidence they rest? One man's many is another man's few; one man's frequent is another man's seldom."

In the histology of neurology examples abound of the employment of clinical methods in scientific research. Of one who may justly be styled a clinical genius, Hughlings Jackson, it has been said with truth that "his advent infused a new spirit into neurology, and was the beginning of that systematic orderliness which now characterizes neurology, more perhaps than any other branch of medical science." Both physiology and pathology owe to him a great debt; and I believe that I am right in saying that his contributions to science, from the discovery of the association of convulsive attacks with lesions of the cerebral cortex, to the wide and important generalizations upon which his fame largely rests, were the outcome of bedside observation controlled by morbid anatomy.

The brilliant researches of James Mackenzie, begun, and largely carried out, in the intervals of a busy general practice in a northern town, lend further support to my thesis; for that work has opened a new era of cardiac investigation, and has changed the aspect of the physiology and pathology of the heart.

I have chosen a very few examples from the past—some of them from days when the clinical thermometer was still unknown, and the bacterial origin of disease was not dreamt of—of researches which conform to every canon of science, and which were carried out at the bedside and in the *post-mortem* room by British clinicians who have obtained places in the medical Valhalla. It would be easy to enlarge the list so as to embrace such men as James Paget, Jonathan Hutchinson, W. B. Cheadle, and that great physician whose death we have so recently deplored, John Thomson of Edinburgh. The inclusion of workers in other countries would greatly swell the roll, and I might equally well have taken my examples from men now living. But,

for my purpose, and for the support of my thesis, the examples quoted will suffice.

If, with the far scantier means at their disposal, the clinicians of the past were able to accomplish so much, how much more may be expected from those of the present and future, who are so far better equipped? Although it is true that the nuggets lying upon the surface have been picked up, mining operations, for which this generation is well equipped, should reveal much that is still hid.

In my young days the maps of Africa showed a border of the known around vast areas of the unknown; and in the medicine of to-day there are still large blank spaces to be filled. What do we really know of the true nature of the leukaemias, despite the many differential blood counts of recent years? These carry us to a point, and seem to be unable to take us further. A new road needs to be blazed out, by the collaboration of the laboratory and the ward.

SCOPE FOR SCIENTIFIC WORK IN CLINICAL MEDICINE.

If, as I have tried to convince you, there is abundant scope for scientific work in clinical medicine, why is it necessary to point this out, and why do we so often hear the contrary opinion maintained, especially by laboratory workers? Is it not because medical men too often do not realize the requirements of scientific method? If we are to hold our own as members of the army of research, we need to see that our work is up to the required standard; that our observations are sufficiently precise, and are confirmed by the method of control; that our statistics will bear examination by statisticians, people whom it is not easy to satisfy, and that our hypotheses are legitimate inductions from facts which are clearly established.

There are, however, obvious difficulties which make it hard and often impossible for the clinician to be as exact in his methods as he would wish. Medicine is always in a hurry. The patient and his friends are only too apt to mistake scientific caution for incompetence; to demand a cut-and-dried diagnosis in an impossibly short time; and to estimate a ready dogmatism above a reasoned uncertainty. Time is often pressing, and the doctor is obliged to act upon very incomplete evidence, lest, whilst he waits for certainty, valuable hours must be lost. He cannot always put his treatment to the test by trying one measure at a time; and, again, he is bound to forego any diagnostic test, or even a thorough examination, if it appears to him that it might in any way be harmful to the patient. These are only a few of the hindering factors which are familiar to all practitioners.

You will have to realize that to a large section of the public all science is under suspicion, and scientific medicine is distrusted. A profession which makes a free gift to mankind of all its discoveries is widely regarded as a close corporation of people who look askance at men cleverer than themselves, merely because they have not had a medical education, or because they base their treatment upon heterodox theories. This phase of thought is by no means helpful to him who would advance the knowledge of disease, and, through knowledge, its treatment.

In conclusion, let me repeat that for the clinician, as for the laboratory worker, and especially for both working in co-operation, there is abundant scope for original investigation—that highest product of the scientific spirit. We are not all built to do such work, and there are excellent investigators for whom an obvious practical aim is a necessary stimulus to research; but for those who are content to seek knowledge for its own sake there are great rewards; for the discovery of a new fact, however small a one, or the framing of a conception which throws a beam of light into some dark corner, brings a satisfaction which is without alloy.

Yet the way of the investigator is rough, and there are many disappointments to be faced. In the words of Ecclesiasticus:

"For at the first Wisdom will walk with him by crooked ways and bring fear and dread upon him, and torment him with her discipline, until she may trust his soul and try him by her laws. Then will she return the straight way unto him, and comfort him, and show him her secrets."

May she show her secrets to those of you who shall elect to tread her path.