# SCIENCE

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## *INTERNATIONAL COOPERATION IN RESEARCH*[1]

THE intellectual activity of the world, scientific, literary or emotional, passes alternately through fertile and through barren periods. Each fertile period has its characteristic peculiarities and though any one generation may not be competent to form a just estimate of its powers and effects, it is able to compare the fruits of its own labors with the harvest of its predecessors. You will probably agree with me that our age is distinguished by having disclosed a vast array of facts which take us nearer to the infinitesimal structure of matter and which reach further into the infinite design of the universe, than the boldest flight of imagination could have foreseen half a century ago. But we do not flatter ourselves that the intellect of our time, judged by the power of individuals, is exceptionally great. No doubt, men of commanding genius are still with us, but they are not more numerous or more original than in former times. What then is the peculiarity that has produced such great results? In my opinion what has been accomplished is due in great part to the spread of higher education, which has evolved an army of competent investigators possessing enthusiasm for research which now, for the first time, is led into useful paths by the few great minds, whose powers thus receive a wider range and become more productive. It is in this that our great strength lies.

[1] Address delivered before the National Academy of Sciences on the occasion of the semi-centennial celebration of its foundation.

The functions of an organization devoted to research are to take full advantage of all available mental resources. Intellect can not be artificially created nor can originality be taught, but whatever intellect and originality exist, may be directed into fertile channels, so that those who have the gift of connecting facts shall not fail because the facts are not available.

The advance of science demands that experiment or observation and theoretical discussion should advance in parallel lines. Without organization, one of the teams on whose joint exertions the advance depends is likely to outrun the other. Thus Newton, when he had formulated his law of gravitation, which connects the orbit of the moon with the acceleration of falling bodies, did not publish his discovery for many years, because he could not verify his theory as closely as he desired. It was only after the French Academy had accurately measured an arc of meridian and had discovered a substantial error in previous measurements that Newton's law of gravitation could be said to be proved. In this case theory had gone ahead of observation; but examples of the opposite kind will not be wanting so long as we have observers concerned entirely with the accumulation of data, content to leave discussion to the dim future. It is one of the objects of organizing science to bring the two factors to bear on each other.

International cooperation in research is necessary because scientific inquiries can not be divided into compartments limited by political boundaries. The very language which we use to express our thoughts is tied down by conventions, some of which we have absorbed as students, but which in the case of new branches of learning have formally to be agreed upon. Our measurements—and all accurate science depends on measurements—have to be expressed in units, and how are these units to be fixed except by agreement? While this will be acknowledged by every one, it is not equally recognized how much our present refinements in scientific research depend on organized efforts. Whether these efforts should be concentrated in a single laboratory or confined within one political unit or carried out by the combined scientific community of the world, mainly depends on the nature of the problem.

It is not my purpose to trace in detail the history of international problems and international organizations; but, rather, to show the great variety of problems in which useful results have already been achieved by international cooperation, and to bring the lessons of the past years to bear on the future.

I divide international cooperation into three categories:

1. Agreement on standards and units of measurement.

2. The distribution of work bearing on the same problem, between different nations, for the purpose of economizing time and expenditure.

3. The investigation of problems which can not be solved unless observations made with identical or similar instruments are obtained from different parts of the world and the records published in a homogeneous form.

I think all are agreed as to the question of units and I need not detain you by giving you an account of the various international conferences which have been held and agreements which have been arrived at on these matters.

As regards problems of the second category, they are those which deal mainly with the cosmos, as a whole, because their solution depends so much on the collection of statistics which exceeds the powers of

individuals or even of single nations. A few examples may illustrate what has already been accomplished. First, and foremost, we have the great star catalogue, initiated at an international congress twenty-five years ago, when eighteen observatories combined to divide the work, each taking a number of zones in the heavens.

The importance of this work will be plain to every one, and we must regret that it is still so far from being completed.

As it is not my intention simply to point out the merits of international work, but also to point out its difficulties, a few words may be said which are not intended as criticism, but which may serve to point out the weakness which arises when there is no central authority which lives longer than the single individual can expect to live.

Pioneers will always be found to initiate a work, but in time they die or retire from office; others take their places, and if these become more interested in fresh problems, the work suffers unless it is effectively impressed on their attention by some permanent body. Where to find such a central body, whose main functions would be to endow an undertaking with sufficient inertia to carry it over periods in which the work may seem to be a drudgery, is a matter which deserves careful consideration.

The completion of the "Star Catalogue," which has given rise to these remarks, is only the beginning of an even greater piece of work. When we have determined the positions and magnitude of stars at any one time, we have only taken the first step towards solving the main problem, and must proceed to measure the proper motions, the parallaxes, and also map the spectra. This work is so vast that all hope to accomplish it within reasonable limits is difficult and has to be abandoned unless our statistical ambitions are lowered, and instead of taking the complete sphere of the heavens we select restricted but typical areas for detailed examination. This has been done on the initiative of Professor Kapteyn, who has secured a sufficient number of voluntary associates who are now carrying out a combined undertaking which has already yielded results of the greatest importance, and you will hear something more of this work from his own lips.

Now the essence of work of this kind consists in shortening the time required to accomplish an extensive task by dividing it among a number of persons. If the work is purely statistical it may be complete in itself, and the published records become then available to any one who requires them. In other cases, the observations may have to be collected by a central authority and treated by recognized methods of statistics or analysis before they become useful to the scientific public. While it is generally the observational portion of the work that is subdivided and the discussion that is centralized, the reverse is the case in the proposal made by Professor Pickering—that one central observatory in a favorable position should furnish photographs in sufficient numbers and distribute them among astronomers all over the world, to be measured and discussed.

Finally, a great undertaking of quite a different character—the "International Catalogue of Scientific Literature"—must be classed in the same category. This catalogue has arisen out of a desire to classify the scientific literature of the world, so as to enable any one who desires to study a certain subject to find out quickly all previous researches relating to it. Practically all nations in which scientific work is carried out have united, each

collecting its own data and forwarding it to the central bureau in London.

I can not pass away from this type of international cooperation without expressing regret that a proposal which was made by the late Professor Simon Newcomb has not been adopted hitherto. When the first program of the Carnegie Institution of Washington was being discussed, he proposed that there should be some central computing bureau established at one place where accumulated data of observation, which required scientific treatment, could be discussed and treated in that way. The number of instances which have come to my own notice within the last few years, in which the existence of such a bureau would have been of the greatest assistance to the progress of science is considerable; and I feel very little doubt that others have also felt the want.

The problems which fall into the third category are mainly those belonging to the important and much neglected subject of geophysics. The time is past when we could separate the physics of the laboratory from that of the earth, and that again from the physics of the universe. The experimenter who now studies the structure of the atom must keep an eye on the sun and stars in order to detect whether celestial observations destroy his theories or give them strength.

Atmospheric electricity and terrestrial magnetism, treated too long as isolated phenomena may give us hints on hitherto unknown properties of matter. A meteorologist, finding out at last that space has three dimensions, and that the motion of air is governed by the laws of mechanics, has converted what hitherto has been a sport into a science.

Before enumerating the international associations which are dealing with these problems of geophysics, let us say a few words as to the problems themselves.

We have, first, to study the shape of the earth and the variations in the gravitational forces which are observed on its surface. We have further to take account of the secular variations of level and of the more or less violent disturbances which accompany earthquakes and earth tremors. By comparing the indications of instruments placed in different localities, we can deduce the rate of propagation over the earth and through the earth of the seismic waves. This yields us important information on the physical properties or material composing the interior of the earth. The cause of terrestrial magnetism is at present unknown, and we have no means at our disposal to attack the problem directly, but the study of the diurnal and secular variations may give us a clue, and deserves our closest attention.

In a similar way, the study of the higher atmosphere and of the high electric conductivity which the air is now known to possess at heights which we can not reach, is also a subject which can only be studied by combined efforts. How are these questions dealt with at present?

We have, first, an International Association of Geodetics, which is an exceedingly efficient body, with a bureau at Potsdam, under Professor Helmert. That association is successful, perhaps, partly because its work has been facilitated in that it had to build on virgin soil. Nothing had been done, to a very great extent at any rate, internationally before that association came into being. On the other hand, we have the International Association of Seismology, a related subject, which was only founded at the beginning of the present century, with a central bureau at Strassburg. This association had to overcome more serious difficulties. It entered into the field when there was already a less expensive organization in existence, which had been originated by Professor Milne

and was directed by a committee of the British Association. The question of instruments also presented peculiar difficulties, which it is hoped may soon be overcome.

As regards terrestrial magnetism, I have only a few words to say.

Through the magnificent efforts of the Carnegie Institution of Washington, we are at last likely to have a satisfactory magnetic survey of the world, but important as the results obtained by Professor Bauer in the *Carnegie* will prove to be, they will have to be supplemented by systematic observations of the variations of the magnetic forces at a number of fixed stations. Many such stations are in existence, though they are very irregularly distributed over the surface of the earth.

In this subject, almost more than in any other, an international agreement on the manner in which the records are to be treated and published is essential, and it is much to be regretted that the attempts that have been made to reach such agreements have not met with greater success. There are, no doubt, peculiar difficulties due to differences in the organization of the magnetic services.

Methods have developed independently in different countries, and there is a natural but regrettable reluctance to alter an instrumental detail or a peculiarity in treating the observation until the necessity of the change has been demonstrated. But that can never be done, because practically all methods are equally good. What is bad is that they differ. Almost any one of these methods could be adopted with advantage anywhere; so that a discussion of which of the methods is better than the other is futile. The first essential then is that in every place on earth the same methods should be adopted, because the least difference in them may cause important errors in the deductions when they come to be compared with each other.

The only body which at present deals systematically with the records of terrestrial magnetism is a sub-committee of the Meeting of Directors of Meteorological Observations. The Directors of Meteorological Observations meeting at intervals have appointed a certain number of sub-committees dealing with a certain number of subjects. Some of these overlap other associations already. So that, for example, the question of solar radiation falls partly under that sub-committee of the directors of meteorological observations and also under the International Solar Union, a union which has been founded by your foreign secretary, Professor Hale.

The present international organizations differ considerably in the manner in which their expenditure is provided for. The International Geodetic Association, the Association of Seismology and the International Bureau of Standards are directly supported by the governments, the contributions depending upon the population of each country and amounting, for the larger ones to—I need not give you the figures now. They are of no particular interest.

The "International Catalogue of Scientific Literature" is a very costly undertaking, and that is provided for by each country guaranteeing the sale of a certain number of copies; a capital fund having been paid to start the organization by the Royal Society of London.

In the case of the great "Star Catalogue," each observatory is responsible for its own expenditure. The four French observatories have received government contributions amounting together to over $500,000. In England a much smaller sum has been given, and in other countries the

work has languished a good deal because sufficient funds were not available.

The Solar Union has no funds whatsoever and is even unable to pay for its own publications. Sufficient has been said to show how wide a range is already covered by international research. Further extensions of the work are constantly being called for, and we are brought face to face with the problem that separate associations can not be multiplied indefinitely without introducing difficulties which, as their number increases, endanger the objects which they are intended to serve. Apart from the overlapping of interests and questions of finance, the time spent in correspondence and administration is already serious. The nature of the problems suitable to be dealt with by international efforts is such that the same persons are generally interested in several of them, and the meetings succeed each other so rapidly as to become a serious tax on the time of those who attend them and some who used to look with favor on international work are beginning to be frightened.

Perhaps we may look forward to some arrangement to combine the meetings of the different associations in the manner of the different sections of the British Association, for instance. But this would require some central authority to act as a bond between the bodies which at present are separate and independent.

Economy of working, both financial and administrative, points in the same direction, and we are driven to the conclusion—and that, I think, I should like to make the moral of this paper—that the present policy of establishing a separate association for each new extension of international work should be reconsidered and an effort made to economize time in working and administration by some larger scheme, including the various separate international institutions on related and similar subjects.

Realizing that it is necessary to take some action in this direction, yet perhaps not understanding correctly why the action is necessary, an ambitious undertaking has been evolved in Belgium, where it is proposed to erect an office uniting international associations, whatever their object or character may be. The promoters have drawn up their statutes, one general congress has already been held, and another is now being organized. No success can, however, be expected from a scheme launched by a self-constituted and irresponsible body, unless its program commands general respect.

Is this the case in the present instance?

I do not know whether you realize the number of associations which exist. I shall not call them "international associations," but associations which call themselves international. The number to be united in this Belgium scheme is 279, and each of them, if I understand the proposals correctly, may have an office in a large building to be erected for the purpose. If you read through the list of these associations, I do not know what your feeling would be, but I can describe to you what mine has been; and it is exactly like that which I should have if I were to enter a museum, and find, side by side, the Venus of Milo, a living tiger, a collection of rare manuscripts and sanitary appliances. You will be interested to hear that, amongst the institutions which are to be provided for in this building, is the International Bureau of American Republics; but it is also intended to include "The International Congress for Providing Cheap Lodgings." Any one who enters the building and tries to find the particular room to which he wants to go has to ask the man in charge.

You can imagine this kind of a conversation taking place:

Is this the International Union of Friends of Young Girls?

No, but it is the International Congress of Commercial Travelers.

The architect, no doubt, will do his best to group together associations relating to the same subjects, and it would be interesting to pass through the corridors devoted to all the religious and irreligious societies that take the name of "international." If a humorist were to exchange the name plates over the doors, the mathematician who has traveled all the way from Australia to attend the "International Congress for Promoting the Study of Quaternions" might find himself in the room reserved for the "International Union of Woman Suffrage," and a member of the Association of Seismology might be mixed up with the "Association to Prevent the Abuse of Alcohol."

I do not like to throw ridicule on what is obviously a well-meant effort, but however much our sympathy may extend to each of these objects separately, no good purpose is served by inventing a connecting link between incommensurate objects, such as solar research and the proper observance of Sundays.

Our work is sufficiently difficult, if we confine ourselves to scientific methods. It nevertheless remains true that it is desirable to establish some central authority which can act as a connecting link between different associations. What should its functions be? It is the essence of all international combinations that they depend entirely on moral force and have no power to impose their decisions. A central authority must therefore be content with offering advice, with the conviction that, if the advice is sound, it will be accepted. Though the existing associations would tolerate no interference with their independence, they would doubtless consider with care any suggestions made to them in the interests of science by an authoritative body. Our problem is therefore to find an authority of sufficient eminence to be generally looked upon with confidence and who could also act as adviser to different governments when they are asked to financially support some fresh undertaking. That is one of the most serious difficulties of the present time. There is a new international undertaking proposed almost every year, and application is made to the different governments for support and money. What is the government to do? To whom is the government to go for advice whether such an undertaking is worthy of support or not? My solution of that question is this: In the International Association of Academies we possess indeed a body fulfilling all the requirements of such a central authority, provided the individual academies constituting the association are willing to undertake the task. The Association of Academies was founded at a conference held at Wiesbaden on October 9 and 10, 1899, the National Academy of the United States being represented by Professors Newcomb and Bowditch. The paragraph of its statutes which were adopted at a meeting held in Paris in 1901 relating to the functions of the association runs as follows:

The object of the association is to prepare and promote scientific work of general interest which has been submitted to it by one of the associated academies, and to facilitate in a general manner scientific intercourse between different nations.

From its origin the association claimed an advisory voice in new international undertakings, and at the meeting held in London in 1904 the following resolution was passed with one dissenting voice:

That the initiation of any new international organization to be maintained by subventions from

different states demands careful previous examination into the value and objects of such organizations, and that it is desirable that proposals to establish such organization should be considered by the International Association of Academies before definite action is taken.

After a period of activity ranging over about twelve years it may be useful to review the work which has been accomplished, but I shall confine myself to the record of its section of science, remarking only that the section of letters has also much important work in hand.

The powers of the association are purely advisory; it has no funds at its disposal and for this reason alone is unable to initiate or support any scientific enterprise unless the individual academies provide the expenditure, as is being done, for instance, in the publication of Leibnitz's works, which has been undertaken by the academies of Berlin and Paris jointly. A complete map of the moon with its features named according to an agreed scheme is in process of preparation and is welcomed by students of the lunar surface. Among the subjects which have been treated, the excellent work done by an autonomous committee appointed to investigate the functions of the brain should also be referred to; and there are a number of various committees which have done good work.

In many cases the association has been called upon to express a favorable opinion on the importance of some international scheme which is independently being pressed upon the consideration of one or more governments. To deliver a platonic blessing is so gratifying a task that applications for it are not perhaps always scrutinized with sufficient care, though I admit that it is better to support a doubtful enterprise than to risk stopping a good one.

The association has been most successful when it has used its influence to press important scientific objects on the attention of their governments. It is in part at any rate due to their recommendation that money was found for the measurement of the great arc of meridian, which, covering 105 degrees, stretches through Russia and Roumania and continues through Asia Minor and western Africa, to the Cape of Good Hope. This is a continuous arc of meridian reaching from the north of Russia to the Cape of Good Hope in which a number of governments—the British government, the German government, the Russian government and the Turkish government—are involved, which is in process already, and is really nearing completion.

It has become the practise during recent years that international organizations established independently place themselves under the protection of the Association of Academies, to which they report periodically. Though the academies exercise no control over such bodies they stand to them as a reserve power willing to help when required.

In all these respects the association has fulfilled the intention of its founders, but has it left its mark to any appreciable extent on the progress of science? Without wishing to underrate the good that this body has done in the past I do not think I stand alone in hoping for a wider activity in the future, and I doubt whether it will long maintain its vitality unless it extends its ambitions as it passes from the age of youth to that of manhood. This is a critical period in its history, and much will depend on the policy it will adopt on a question which may still be kept in abeyance for a short time, but which will have to be faced before long.

An international organization which has no central office and is not domiciled in

any country is not a legally constituted body. It possesses no property. It can not accept gifts or legacies. The question has been repeatedly raised whether it is desirable to remove this restriction and to establish the association on a legal foundation. For this purpose it would have to place itself under the laws of some one country, and the selection of that country complicates the decision on the main issue, as national consideration and perhaps to some extent national jealousies have to be taken into account.

To clear our minds, let us separate the two issues, that of the power to hold property and that of a permanent domicile. Each academy knows from its own experience that though individual research may often be carried out at a small cost an organized investigation demands funds which become considerable when its range is wide. It is therefore just the type of work that an international organization is best fitted to undertake which demands the greatest amount of assistance.

The question to be faced is this:

Shall our International Association be forever content to exercise a purely platonic patronage, or shall it take an active part in promoting research? If it chooses the latter course it seems to me to be indispensable that it should have funds at its disposal.

I advocate the bolder policy on two grounds: Firstly, international research is most logically administered and paid for by international funds, and, secondly, it seems to me that a purely moral support can not, in the long run, remain effective. The existing special associations, as I have already stated, must retain their complete independence, and it is not likely that it will ever be desirable that the Association of Academies should undertake any work in which financial support is expected to extend over a considerable period; but when promising enterprises are in their experimental stages, funds are often most urgently required and most difficult to obtain.

It is here that an international body, having an independent income, could most efficiently step in to support meritorious enterprises during the few critical years until they can be either established on a permanent basis or have completed their work.

I recognize, of course, the weight of certain objections which have been raised, but I think we must run the risk all the same, for my experience teaches me that there is seldom any vitality without antagonism; and the main ground of objection is that we are going on so nicely, we never disagree and therefore we had better remain as we are. But after all, our progress is only obtained by those having differences of opinion coming together and adjusting their differences.

Even should the general opinion be against me, and if it were definitely decided that the International Association of Academies should forever maintain its present state of poverty, the establishment of a domicile on a moderate scale will have to be considered as an independent issue. It might be mentioned that in the original proposals of the Berlin Academy, they intended that there should be not only a central bureau but an organ, published monthly or quarterly, giving an account of the work done by any one academy that would interest the other academies.

The policy which the International Association of Academies will adopt on these questions is one of the most vital importance, for not only will the future of international work depend on the course

taken, but the reputation and influence of the academies themselves will, I am convinced, be seriously affected by the decision.

It is with the greatest hesitation and with much diffidence that I now approach the concluding portion of my discourse, for I am oppressed by the fear that my remarks may be taken as an unnecessary interference in the concern of others. But the issue is too serious to let that prevent my expressing an opinion which is based on a deep, and I believe impartial conviction.

The academies, royal societies, or whatever name they are called by, have been founded at different times in accordance with the varying requirements of their countries. They value their historical traditions above everything; some are over two hundred years old, others of recent growth, and their constitutions differ in many respects. But whatever their constitution and their history may be, they must be judged by this same test: Do they fulfill their obligations, which for all of them, I take it, are those defined in the charter of the Royal Society as "The promotion of natural knowledge." Do they embody in themselves the promotive power of the scientific efforts of their country, or have they fallen a prey to the dangers, which more especially beset the older institutions, of crystallizing into an aristocracy of science, recruited from those who in the natural course of growing maturity are ceasing to be active workers and constitute themselves to be the judges of the work of others? The dead weight of such a society brought to bear discretely on the exuberance of youth may have its uses, but it remains a dead weight just the same. It should act as a brake on a too fanciful imagination, but it can take no share in any real progress. If the academies are to fit themselves for the formation of a really strong and fruit-bearing association, they must be bodies which, animated, as all of them now are, by the highest and noblest ideals, strive at the same time to represent what is best and most progressive in the scientific life within their range of influence.

Each country must solve its own difficulties, but in addressing your national academy which, though it holds to-day its first jubilee, may still be called youthful, I may be forgiven if I remind you that, while the older institutions may offer you much that deserves to be admired and perhaps be imitated, you must not mistake the signs of gray hairs for the stamp of an enviable dignity.

This, then, is my final summary. Ours is an age of organization presenting many problems that can not be confined within political boundaries. The demands of science have already called into existence separate international associations, which are efficiently performing their duties. Nevertheless the continued increase of their number is beginning to cause inconvenience and is likely to hamper future developments unless they can be united by some bond intended to coordinate their work. The International Association of Academies stands out as a natural body, fit to act as a central advisory authority. To exercise that authority effectively, the academies must individually recognize their obligations to be truly representative of the most healthy and vigorous portion of the scientific life of their country. It is because I believe in the vitality of the academies and in the power which an increased responsibility will give them to check the danger of stagnation to which ancient and dignified bodies are exposed, that I advocate the extension of their activity and the

more vigorous exercise of the dormant power which resides in the union of the illustrious bodies which together constitute the International Association of Academies.

ARTHUR SCHUSTER
ROYAL SOCIETY OF LONDON

## *SIR WILLIAM OSLER'S SILLIMAN LECTURES*

SIR WILLIAM OSLER delivered the first of his six lectures on the "Evolution of Modern Medicine" on the Silliman foundation at Yale University on Monday afternoon, April 21. The last lecture was delivered on the 28 ult.

In his first lecture, according to the report in the *Yale Alumni Weekly*, Dr. Osler dealt with the origin of medicine in primitive man and its relation to magic and religion. Certain special practises, such as trephining, were described and illustrated by the lecturer. Egyptian medicine was considered in its three important aspects—magic, the use of animal extracts, and the specialized modes of practise recorded in the famous Ebers, Hearst and Berlin papyri. Divination, particularly by inspection of the liver, astrology and the Hammurabi code, were taken as illustrating the special features of Assyrian and Babylonian medicine. The extension of astrology was traced through Greece and Rome. Among the Hebrews the excellent hygienic regulations were discussed and brief reference was made to the miraculous healing in the New Testament. Dr. Osler showed that the character of ancient medicine may be studied today in China, where charms, enchantments and death-banishing herbs are universally employed.

In the second lecture Professor Osler dealt with the beginnings of science in Greece, dealing first with the nature philosophers of Ionia and south Italy, whose contributions to medicine, while not numerous, were of great importance as influencing the thought of subsequent workers. The physicians of this school were independent of the Osculapian cult, the growth of which he then sketched as met with at Epidaurus and Cos. The work of Hippocrates was discussed and his fundamental proposition that disease was a natural phenomenon to be studied. The high ethical character of Greek medicine was illustrated by the famous oath of Hippocrates. The rise of the Alexandrian School and the study of human anatomy was then considered, and the high-water mark of the period was reached in Galen of Pergamus, whose life and work were described.

In the third of his lectures he treated medieval medicine. He traced the stream of Greek medicine through the three channels in the middle ages—the first continuous Greek tradition in south Italy, which found its highest development in the School of Salernum; secondly, through the Byzantine sources; thirdly, through the Arabs, who by the ninth century had had translated for them all of the Greek writers. From the Spanish translators of the thirteenth century, from Salernum, and by the dispersion of learned Greeks with their manuscript after the fall of Constantinople, Greek medicine reached modern Europe. He then traced the growth of the universities of Bologna and Montpelier and their influence upon medicine, particularly the former, where anatomy was first studied. Medicine of the middle ages was a restatement from century to century of the facts and theories of the Greeks, modified here and there by Arabian practise. In Bacon's phase there was much iteration, small addition.

In lecture four Professor Osler dealt with the beginnings of modern medicine as illustrated in the lives and works of three men. Paracelsus represented the spirit of revolt against authority and tradition. His positive contribution to medicine was small in comparison with the stimulus which his antagonism to the older writers aroused in his generation. Vesalius was the first to describe and illustrate with system and accuracy the structure of the human body. He may be said to be the creator of human anatomy as we know it. Professor Harvey Cushing, of Harvard,