

SCIENCE

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RESEARCH FOUNDATIONS IN THEIR RELATION TO MEDICINE¹

At this time and place, medicine is the central interest, and therefore, so far as a layman can, it is my purpose to discuss "Research Foundations in their Relation to Medicine," and if possible to do this in such a manner as to reveal their significance to those for whose encouragement these ceremonies have been devised.

To accomplish this I intend first to ask you to consider the mental attitude necessary for the appreciation of research foundations and then to describe these foundations broadly—trying to indicate their relations to the universities; the problems which arise in connection with them; the dangers to which they are exposed; and their significance for the progress of medicine, for yourselves and for the development of the spirit of research.

You who are about to pass from the discipline of the school to a more self-dependent phase of your career feel both the fresh pleasure of restraints outgrown and a questing interest in the coming years. You feel too that, broadly speaking, what will happen to medicine during the next fifty years will also happen to you, and that at any moment some of you may be called upon to guide these happenings.

In the face of such responsibilities it becomes a duty as well as a wise precaution, to obtain the broadest possible view across your chosen field and to gain knowledge of the larger changes and improvements taking place within it.

You may have done this several times

¹Address at the graduation exercises of the Yale Medical School, June 17, 1912.

before, but I venture to predict that if you live and succeed, you will do it many times again.

The Greek philosopher Heraclitus laid weight on the idea that all things are in a state of flux. The notion has not always been approved. We know that this idea in some of its aspects was repugnant to the early Victorian gentlemen, but to-day we are less prone than those of earlier generations to dogmatize on the impossible, and in this country and this phase of civilization, we feel with its full force the forward flow of things, so that for us nothing is more certain than the progressive change and onward movement in medical theory and hence in medical practise.

During the years of your training you have been carried more or less unconsciously along and thus helped to keep in touch with the development of medical thought, but at this moment, when the stream of knowledge is about to cast you out upon its shores and you are asked to walk on alone, it is worth while to inquire what is your preparation for the experience.

From these halls and laboratories you bear away a load of learning—haply you bear it lightly. It is to this possession that I wish to direct attention for a moment.

The knowledge we accumulate is a very mixed article, but in this mixture there are two sorts which it is well for us to consider now. One sort consists of certain formulas which control our incidental actions; for instance, we all know on occasion when to stand up or to sit down, and you know the technique and procedure for various surgical operations. A great fraction of our information is in this form, a form not necessarily subject to frequent or radical change. This sort, however, is of minor interest to us now, and has been mentioned here only that it may serve as a foil to the more important kind.

This more important kind of knowledge is that on the basis of which we can foresee and predict.

There are manifold varieties of this and they range from that which permits us to predict with a high degree of confidence the rising of to-morrow's sun, to that with which one ventures to predict the weather or the fate of a patient with baffling symptoms.

In these latter instances the course of events is by no means unpredictable, but only so dependent on complex factors and conditions that we rarely have at once at hand enough information to make a respectable guess. This fact bears very directly on the matter before us, for when we scrutinize our intellectual possessions we find them to consist in large measure of information useful for prediction, yet mainly information so incomplete that the conclusions or theories—if you choose—based on it must be largely held as open to revision and therefore can be used with safety only by those who carry in mind just how much or how little each conclusion has to rest upon. Nevertheless, it is just these tentative conclusions or theories which the medical man must so largely utilize. Probably you have thought of this before; if so, you know that to the revelations of this analysis men react in very different ways. Some throw up their hands in the face of so much uncertainty; others stretch certainty to the limit and seek to make it cover all they have been taught and then cultivate impenetrability because change is disquieting and new knowledge means new labor, while those born under happier stars are neither crushed nor blinded, but recognize that intellectual health and vigor imply an unceasing replacement of both data and conclusions, to be accomplished only when the period of

mental growth is made conterminous with life.

Capacity for such continued growth is conspicuous in the masters and a hall mark of the eminent. Indeed, as you proceed in the investigation of your fellows, you will be surprised to find how early growth may cease and how significant the event can be. In far-distant communities mental growth has been known to stop on commencement day. It is consoling, however, to be assured—as I can assure you—that we observe this woeful arrest more clearly and sooner in our fellows than in ourselves—a suggestive fact which needs only to be mentioned in order to be appreciated.

As you see, the reason for this preface touching the nature of our mental possessions is my wish to emphasize the need for the full recognition of the unsolved or partly solved problems in medicine and the necessity for holding in mind the facts on which all such tentative solutions as we use are based. When this need has been recognized, it is possible to take the point of view from which research foundations can be discussed with greatest benefit, for primarily it is their purpose to replace less certain by more certain facts. Indeed, discussion of these foundations can be significant only for those who, like yourselves, know that the students' career is for life, never to be commuted—not even for good behavior—and in no wise limited by any formal function, such as graduation or a state board test.

Turning now to the research foundations themselves, it may be well, by way of introduction, to give a word of explanation touching the coming treatment of them. I desire to speak as an inquirer, not as an advocate, but as these inquiries have led me to some definite conclusions, I shall venture to express them briefly. Beyond this, all things rest with you.

While we are specially interested in research foundations in their relation to medicine, yet those with such relations are but a fraction of the number in existence and for the most part have come late.

A research foundation may be defined as one especially intended to produce new and better knowledge. Thus the main purpose and aim serves broadly to differentiate such a foundation from the universities and other educational establishments in which a greater emphasis is put on the conservation, distribution or application of knowledge, while at the same time both sorts of institutions have been and are producers also. The new foundations are then by no means essentially novel, but in one sense outgrowths or specialized extensions of the older educational establishments. This implies of course that what they are devised to do has already been included in the existing scheme of things.

Such being the case, our discussion must be framed so as to comprise these facts.

In the civilization from which we are descended there has always been some endeavor to add to the sum of human knowledge.

The acute minds belonging to the end of the medieval period often overstepped the theological and philosophical bounds within which they had their greatest activity, and gave to the study of the physical world more or less attention. Speculating, compiling, teaching and even experimenting, these men grouped here and there formed the centers from which the earliest universities of our era sprang.

Later appeared the learned academies, also sometimes the patrons of investigation. As objects of study, the physical problems came first, aided by the fact that observational and experimental work could be there begun without the preliminary labors of collection and classification which have

necessarily occupied so much time in the biological sciences.

What is important to point out here is this: That whether we date the founding of the modern university laboratory from Lomonosoff at St. Petersburg in 1748, or from Liebig at Giessen in 1826, we must admit that a good deal of investigation had gone on in all the principal departments of science previous to such foundations, and thus in earlier times investigations were made in scientific workshops unconnected with teaching institutions. This fact suggests that perhaps our research foundations have even less novelty than we were at first inclined to accord to them, and that we are dealing now rather with a reappearance of conditions—much improved, to be sure—but quite familiar before the rise of our modern universities. It has a direct bearing on this point to note that in England, for example, during the earlier part of the last century when the historic universities of that country gave only meager support to experimental science and especially to the biological investigations, much of the most important work was done outside of the teaching institutions.

Joule, the student of the mechanical equivalent of heat; Perkin, discoverer of the aniline dyes; Bentham and the Hookers, all three botanists; Galton, the anthropologist, and Darwin, are some instances.

Moreover, for more than a century the Royal Institution of Great Britain, the foundation of which in 1799 was largely instigated by our fellow countryman, Count Rumford, furnished opportunities for research to Davy, Faraday, Tyndall and Dewar, all men whose contributions to knowledge have been of great importance.

According to its charter, the Royal Institution was “an establishment in London for diffusing the knowledge of useful mechanical improvements” and “to teach

the application of science to the useful purposes of life.”

This does not sound like the program of a research institution to-day. I can not say just what the steps were which led in this case to a development seemingly so different from that proposed, but it is not rash to assume that the men like those who have been named were always hunting reasons and explanations, knowing quite well that others could carry out the application, while it was theirs to make the fundamental discoveries; an excellent example of the well-known fact that where an institution and a strong man are left to work out the problem of adaptation, it is the institution that gets adapted.

Returning from this diversion to our history, and taking the period from the middle of the preceding century to the present day, one can not fail to recall in this country such an example as the Smithsonian Institution at Washington, and I would add our agricultural experiment stations which started right, then faltered, but are now coming into their own.

More extensive in scope and with far greater resources than any of these is the Carnegie Institution of Washington, whose magnificent undertakings in the field of science are well known, representing as they do a long series of research stations.

The ideas behind these several foundations are of the greatest interest. In his program of organization, in 1847 Joseph Henry, first secretary of the Smithsonian Institution, states the following:

To increase knowledge: it is proposed (1) to stimulate men of talent to make original researches by offering suitable rewards for memoirs containing new truths and (2) to appropriate annually a portion of the income for particular researches under the direction of suitable persons.

This is what one might expect from Joseph Henry.

Touching the agricultural experiment stations, the history is complicated and perplexing, but we are justified, I believe, in carrying back the guiding idea in their development to that expressed by Washington in his annual message to Congress in 1796, where he says, when pleading for the establishment of a national board of agriculture, that one of the functions of such a board should be "to encourage and assist a spirit of discovery and improvement . . . by stimulating to enterprise and experiment." This is certainly sound doctrine.

The Carnegie Institution in the original formulation of its general plans was much influenced by the experience and early program of the Smithsonian Institution, but the original statement of aims strikes a new note when it declares one of these aims to be

To discover the exceptional man in every department of study whenever and wherever found, inside or outside of schools, and enable him by financial aid to make the work for which he seems specially designed, his life work.

It is said that this paragraph touching the exceptional man has caused much trouble to the Carnegie Institution and often spread its path with thorns. It appears that in some instances it has been misunderstood. Self-discovered exceptional men have proved to be embarrassingly numerous. That does not strike one as so very strange, however, since the community grows wise but slowly.

The word "exceptional" you see has suffered misinterpretation. The really exceptional man is not so often the aberrant prodigy as the individual who presents in his composition a large collection of first-rate qualities, no one of which is necessarily alarming, but all of which together make for scientific effectiveness of the highest order. In the course of its development, the Carnegie Institution has, I think,

lived up to this ideal with notable success—putting the saner interpretation on the word "exceptional." My commendation of the paragraph is similarly based.

But none of these instances which I have mentioned—together with a large group of others—come very close to medicine. This contact was first clearly established in 1888 by the Pasteur Institute in Paris, an institute intended to facilitate the work of the great scientist whose name it bore, and to continue the remembrance of him. It was an instance of the generous giving of aid and assistance to a master-man—with no prescriptions and no hampering limitations. Pasteur was a genius who combined the art of mediation between the laboratory facts and practical problems, with the capacity for speculative thought and scientific achievement in the highest sense, and who, nevertheless, did not allow his human interest to impair his scientific thoroughness.

In this country among the foundations closely related to medicine we have recently seen established the Rockefeller Institute, the Memorial Institute for Infectious Diseases, the Ortho S. A. Sprague Memorial Institute, both of these at Chicago, together with a number of others representing much the same purpose, but with less ample resources, as well as several funds devoted to the study of cancer, tuberculosis or other special diseases. These instances, because they touch medicine, might well be examined in detail, but we shall discuss them only in their most general relations.

It seems a fair question to ask why these institutes and funds have been established. The immediate causes are plain enough, and are frankly philanthropic in most cases. Personal experience with a disease has led more than one man to devote a large sum to the search for its control or cure or going a step further, and recognizing that the application of laboratory

results to medicine has brought progress, some have desired to furnish opportunities by which this application may be accomplished where it seemed most needed. Though not always explicitly expressed, the programs of these foundations imply the hope that by such endowments new facts and new points of view fundamentally important to medicine may be discovered.

I like to think that this last idea is at least latent in all these endeavors, but nowhere, so far as I know, is quite the same note struck as that which is sounded in the initial program of the Carnegie Institution in those words which call attention to the exceptional man—the investigator.

Turning now to some of the relations involved, it is to be observed that these new foundations are independent and not connected with existing universities, that they tend to draw men from university positions by the attraction of unusual opportunities for work, and finally, that for the most part they take these men away from formal teaching.

The situation thus created in the world of education has often been lamented and no little moral pressure is exerted from time to time to induce the institutes to see the wrongness of their position.

The question thus raised amounts to this: Are these new foundations philanthropic vagaries and mere torsos of educational establishments, or do they represent the result of mature consideration and a definite endeavor to advance?

Of the several reasons which have brought about the independence of these foundations the common desire to keep alive the donor's name and fame has played its part, but more than this I think has been the feeling that since these foundations were to be devoted to research, either in the line of mediation to which I have already referred, or in the endeavor to

obtain new truths of fundamental importance, therefore the workers in these institutes should be as far as possible released from any duties likely to divert their energies. To make this arrangement within the limits of a university is, to say the least, to subject the favored appointee to no little strain.

His colleagues, being human, at heart often resent his seeming freedom from responsibility and he is allowed to feel that somehow he does not justify himself by attending to his work alone. It is unnecessary to enlarge on this situation, but I can assure you that it is no mere product of my fancy. Separateness of management brings protection therefore to those who choose this work.

Still more important for ultimate success is the general conduct of such a foundation. Our universities are guided by experienced administrators who feel keenly the need for the diffusion of knowledge, for making it accessible to large numbers and for preserving withal a completeness and balance in their institutions.

These views become ingrained, but they do not represent the aims of a research foundation and the same board could hardly manage both with like success. For the investigator, buildings are fine when they suit his purpose; after that he loses interest. His notion of efficiency is a large emergency fund and whether the fixed charges are great or small is not so important as the means to act promptly, decisively and even expensively when occasions arise. This arrangement is possible only when the institution is a good deal of a unit and absolutely free.

To appreciate the needs thus briefly outlined requires the experience which breeds sympathy, and it has thus come to pass that so far as the arrangement of the scientific program, the formation of the personnel

and the expenditure of funds are concerned, the control in many of our institutes is in the hands of the staff, aided by a small group of scientific advisers, themselves active workers and keenly alive to the needs of the investigator. This leaves the actual care of the funds with the trustees, but puts the scientific activities in the hands of scientific men. The arrangement solves several problems and seems essential for the healthy development of research foundations.

In view of all of these facts it does not appear very strange that independence has been desired for the newer establishments.

This brings us to the problem of getting men—men who will attempt to realize the highest aims and aspirations of these foundations. These have been taken largely from university laboratories and have been attracted to the newer work by the prospect of more time and resources to apply to their chosen problems and by more fitting salaries.

Of course it has happened at times that in arranging the program of some foundations, emphasis has been put on finding the answer to some specific question which was in the donor's mind. This is unfortunate so far as it implies a limitation of the scientific work, but on the other hand, in many cases the investigator has been given ample freedom to pursue his own course and devote his time to matters often seemingly remote; in other words, to follow where his research led. The situation demands above all things faith in the sincerity of purpose of the investigator, and fortunately this is granted with increasing frequency.

In these institutions which serve to mediate, on the one hand, between the findings of science and practical problems, and on the other to give opportunity for the attainment of fundamental facts, there is a constant danger threatening every searcher

after new knowledge. The mediation work, because it involves as one element a practical problem, is moderately intelligible to the laity and extremely handy when it comes to giving an account of things done. It may become thereby unduly attractive.

By contrast, the search for the new knowledge is rarely intelligible to the community at large, and must often be described in terms of things in mind rather than of things accomplished, and thus this kind of activity often lacks for encouragement. Let me illustrate. Some years ago the need of protection from diphtheria was urgent. The infecting organism and its biological characters, on the one hand, were known; on the other, the dread disease was only too familiar. How could laboratory knowledge be used to solve the clinical problem? You are familiar with the answer which was given in the form of the diphtheria antitoxin. That is a splendid example of work in mediation as done in research institutes.

But a further question arises: How does the antitoxin produce its effect? This is quite another sort of problem; at first glance it appears to have little practical bearing and yet the answer to it in even one instance may lead to a wider view of the processes of immunity. The solution of problems of this class is different from the work of mediation, certainly of equal rank with it, and yet in every way harder to support and harder to carry on, since the results can not in the first instance possibly appeal to any save the well-trained few. In this there lies an obstacle to progress which you can largely help to remove.

Because the men who can do this latter kind of work are relatively rare, even among investigators, because such work can have rational appreciation from a limited group only, and because knowledge of this sort is sure to become the basis for many

mediations in the future, it behooves us all to see to it that we foster such investigators—the most valuable of our natural resources. Perhaps it occurs to some of you that you have seen one well-known type of the man I here commend. Let me recall him to you.

An elderly gentleman with an unprogressive costume and unsteady gait, who generally fails to recognize his friends upon the street and requires several seconds to accomplish the recall when spoken to. Such is the mildly humorous picture with which all are familiar. It is often correct so far as it goes—only it is a bit incomplete.

One should add that this man is working with his head, a fact which accounts for almost everything and leaves us pondering why this symptom complex so readily excites remark.

Connected with the conduct of research in these foundations are several other problems of more than passing interest. The fear is sometimes voiced that in the absence of students, those at work will lack an important stimulus and suffer deterioration.

The danger varies with the man. Instances are known where men have failed to feel the attraction of institute opportunities, because they feared the loss of this companionship.

On the other hand, we have the attitude represented by the German university professor who is said to have remarked at the opening of the fall semester, "Now comes this disagreeable interruption of my work." Doubtless he was a wicked old dyspeptic, but for a moment he rose beyond himself and spoke for his burden-bearing caste.

Let me beg not to be misunderstood. I would not for a moment be thought to maintain more than the simple thesis that while teaching is a genuine stimulant to some, it is certainly a depressant to others and especially a depressant to those who are

disturbed by interruption, so that some can drop it without damage to themselves.

In compensation it may be urged that the effect of the investigator's methods and personality is felt by those with whom he is usually surrounded, his colleagues and assistants, and when so surrounded he is in no more danger of isolation than a man in the university. However, that is not saying very much, for isolation among colleagues even in universities is a condition which we not only lament, but should also seek to change. It is an ancient tale.

The investigators of four centuries ago were chary of talking of their results and these were often published posthumously, as the authors preferred to die without assistance—or the new discoveries were sometimes couched in cryptic writings as though the author felt that what had given him such years of labor to find out should at least be hard for others to attain. That feeling is sometimes found to-day.

Once I remarked to a student, "Your thesis is three times too long." "Yes," he replied, "but if I did not make it long, how would any one know it had taken me two years to do the work." We can replace this by a better thought. The opportunity to satisfy one's longing for research is a noble privilege, but it brings its obligations. The advances thus made should be returned as rapidly as possible to the fund of common knowledge, and made accessible to the community at large.

This is essential for the progress of the plan, for most surely is the advanced worker dependent on his colleagues as they on him, and ultimately too he is in a larger sense also dependent on the community about him; so for both these reasons cooperation of the most complete sort is needful for the common good.

Expression has been given to the fear that the great resources of our research

foundations would breed despondency among those who were compelled to work with simpler devices and less ample means, and thus they would do harm. Despondency and research do not dwell together.

Research is a frame of mind. A man may have little leisure and trifling resources, may never have published, but if he examines his world in a questioning spirit, if he carries with him not only conclusions, but the observations on which they rest, if he refuses to pound square facts into the round holes that he happens to have in hand, he has attained illumination. The spirit of research is nothing mysterious or remote, it is every-day hard sense. Unfortunately, that does not make it common, but it does make it attainable. It would be a sorry outcome of these new foundations if they should act as hindrances to investigation in the university laboratories.

The fear that they will do this is often based on the false impression that the supply of scientific problems is limited and thus in danger of exhaustion. Let us be rid of that idea. Every advance creates new problems, problems of increasing importance—exhaustion is impossible.

By reason of the permanency of their programs and freedom from certain forms of responsibility, institutes may wisely undertake investigations of a sort hardly possible under university conditions. The field is thus divided, or rather enlarged. Both the university laboratories and the institutes should gain by this arrangement, and what is more, they do.

Before leaving this aspect of our problem, permit me to point out a peculiar advantage enjoyed by investigators who are working under university conditions. When we contrast the institutes with the universities, we find that it is within the walls of the university laboratory that it is

most easy to carry on the search for new knowledge undisturbed by the thought of any applications which it may have.

In the face of some things already said, this statement may appear paradoxical—yet it describes a condition. In the judgment of the educated public, the teaching investigator fulfills his public obligations when he gives a stated amount of instruction. After that, there is a general feeling that the man should be allowed to follow his bent, and if this takes the form of research, the community does not feel obliged to inquire too closely concerning the practical value of the work. Thus in a way the university man is protected in his research by his teaching obligations, while the man in the institute, engaged in the same sort of investigation, is, if anything, more open to criticism, and at the same time without the defense which is possessed by his university colleague, and in so far he stands at a disadvantage.

As you see, I have been concerned in this address with medicine as represented by yourselves in relation to the research institutes, and that explains the manner of this presentation.

It has been my purpose to show that in these foundations we have something which represents an advance in our educational devices.

Their independence is an asset. They may be counted on to mediate in a measure between the initial facts of the laboratory and the problems presented by disease, but more important, though harder to maintain, is their function as laboratories where new knowledge is obtained, which in turn must have still wider applications.

All this concerns you who are just entering on your life work. You can receive direct benefits and enjoy new privileges by reason of these greater opportunities, but they also bring to you fresh responsibilities.

So far as any of you look upon these foundations from without it is my hope that some things have been said which will rouse in you a sympathetic appreciation of the kind of work which I have sought to emphasize as the most precious type of endeavor, for further progress will depend largely on the appreciation and support given to this by the best elements in the medical profession.

The material side of our advancing civilization has developed during a thousand years to an astonishing degree, but we must not be misled, as sometimes happens, into confusing material developments with intellectual progress. These foundations of to-day are but aids to active minds that use them. The mind, the man, is the essential thing, and any device which does not improve him and give him the very best opportunity to increase his powers, has but slight claim to our regard. I desire, therefore, to leave with you a strong impression of the paramount importance of our mental attitude in establishing the right relations between research foundations and medicine.

Permit me then in closing to quote a little fable from Luqman, as it seems to emphasize this point. Luqman, the sage, was reputed, I am told, to have been either an Abyssinian slave of King David or the son of Job's maternal aunt. That question is not settled—but his fable has a pleasant oriental flavor. It runs as follows:

In the heat of the day the lion retired to a cave. While resting there a rat ran over him. The lion jumped up in fright, whereat the jackal laughed. Perceiving this the lion said, "I was not frightened at the rat, but at my own alarm"; thus showing that to the mighty their state of mind is of more moment than death itself.

HENRY H. DONALDSON

FAMILY RECORDS OF GRADUATES OF WESLEYAN UNIVERSITY

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WESLEYAN UNIVERSITY was founded in 1831, and the first class graduated in 1833. The total number of graduates, including the class of 1910, is 2,849—2,627 men and 222 women. The following statistics relating to married life are given separately for men and women. The first women graduates took their degrees in the decade 1871-80.

1. *Marriages*

In the first decade, 1833-40, 119 out of 142 graduates married (84 per cent.); 21 of them married twice, 3 of them three times, 1 of them four times and 1 five times. In the second decade, 1841-50, 217 out of 264 married (82 per cent.); 47 married twice, 4 three times and 1 four times. In the third decade, 1851-60, 250 out of 276 married (90 per cent.); 50 married twice, 5 three times and 1 four times. From 1861-70, 239 married out of 262 (again 90 per cent.); 37 married twice and 6 three times. In the fifth decade, 1871-80, 271 out of 311 male graduates married (87.1 per cent.); 41 married twice and 1 three times. Five out of the 8 women graduates in this decade married. In the sixth decade, 1881-90, 268 out of 340 of the men married (78.82 per cent.), 14 of them having married twice. Fourteen out of the 29 women graduates of this decade married, that is, 48 per cent. In the seventh decade, 1891-1900, 344 out of the 461 male graduates married (74.62 per cent.); 10 of them married twice. Fifty-one women out of the 95 who graduated in this decade married (53.68 per cent.). In the last decade, 1901-10, 221 men out of 570 have so far married (38.8 per cent.); 3 of them have married twice. Twenty-six out of the 90 women who graduated in this decade have married (28.8 per cent.).

Of the 2,627 male graduates, 1,930 have married (73.46 per cent.). Of the 222 women graduates, 96 have married (43.28 per cent.). The percentage of married women compared