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THE CAREER OF THE INVESTIGATOR[1]

SCARCELY more than a generation ago the graduate in medicine had his professional career marked out for him with a fair degree of definiteness. Private practise, as exemplified in the functions of the family physician, offered, apart from surgery, almost the only opportunity for the use of a medical training. During the past thirty years how extensively have medical activities become diversified. The paths of service that now invite the young physician are so varied that every graduate should be able to select a way for employing his peculiar powers to the best advantage. Quite apart from the conventional career of the physician, the surgeon, or the different specialists, are the opportunities for usefulness in the widespread movements which are socializing medicine. In professional service at hospitals and sanatoriums important work can be done; in boards of health, municipal, state and national; in public propaganda for temperance, for the prevention of infant mortality, for industrial hygiene, for the care of school children; in the campaigns against tuberculosis and venereal disease —in all these activities the possibilities of applying a medical education usefully to social needs are numerous and are yearly increasing.

Still another new career open to the young graduate is that of research in the medical sciences. For attracting young men into scholarly careers the medical sciences are, I suspect, at some disadvantage compared with other natural sciences.

[1] Address to the graduating class of the Yale Medical School, June, 1911.

Such subjects as zoology, botany and physics, for example, taught in the colleges, recruit their investigators from students who, in undergraduate days, before their life-purposes are definitely fixed, find the pure interest of the science a motive which determines their whole future. The medical sciences, on the other hand, are usually presented to students only after they have decided to fit themselves for practise in a highly attractive profession—that of mitigating the physical sufferings of their fellowmen. The medical sciences become thereby merely a means to a particular and predetermined end. And not infrequently the laboratory courses, because they defer the time of coming into direct and helpful contact with human beings in need, are regarded by medical students with impatience. To men who take that attitude, scientific investigation, because of its remoteness from the distress and the critical struggles of sick men and women, is apt to seem trifling. Perhaps they look upon the investigator with benevolent interest, or as a teacher they may like him, but they will, with fair certainty, remain indifferent to his scholarly occupation.

Because the attention of medical students is fixed so definitely on the practise of their calling they may entirely fail to understand the nature of scientific research, the sort of value which it possesses, or the incentives which impel men to its pursuit—in short, they may remain quite unaware of what productive scholarship in the medical sciences really implies. Yet the work of investigation is of prime importance to medicine, and it yields some of life's profoundest satisfactions to the man who pursues it. Among the multiplying opportunities open to persons with medical training, should not the career in research be better known and appreciated? It offers such important possibilities of serving not only one's own generation but all future generations as well, and it grants rewards so generously to those who embrace it that I propose to discuss with you some of its characteristics, and some of the qualities of those who pursue it successfully.

In a medical school as in other institutions of technical education the emphasis must be placed on what has been confirmed by experience, on what is well known and established. To point out repeatedly what is not known, or where lie the boundaries between our knowledge and our ignorance may be an interesting intellectual exercise, but it does not alleviate the sufferings of the sick or help to meet any immediate practical emergency. Nevertheless, it is our ignorance of disease and its conditions that limits absolutely our effective grappling with many of the most distressing afflictions of mankind.

The investigator is first of all one who thinks as much of what we are ignorant of as he does of what has already been made clear. His chief interest is in the territory which has not yet been traversed. Indeed he is to be classed with explorers and pioneers. For such men the complacent contemplation of things accomplished is intolerable—they chafe under the routine of established ways, and find the satisfactions of life in adventures beyond the frontiers. Harvey, among the first of modern discoverers, expressed the spirit of research when he wrote:

> It were disgraceful, with this most spacious and admirable realm of nature before us, and where the reward ever exceeds the promise, did we take the reports of others upon trust, and go on coining crude problems out of these, and on them hanging knotty and captious and petty disputations. Nature is herself to be addressed; the paths she shows us are to be boldly trodden; for thus, and whilst we consult our proper senses, from inferior advancing to superior levels, shall

we penetrate at length into the heart of her mystery.

And in another place he wrote:

> Truly in such pursuit it is sweet not merely to toil, but even to grow weary, when the pains of discovering are amply compensated by the pleasures of discovery.

As children we all have an instinctive curiosity concerning the world about us, a curiosity which most of us gradually lose as we fit ourselves into the social conventions. The investigator is one, however, in whom this natural curiosity still persists. He has never got past the annoying stage of asking "Why?" The events occurring on every side which are matters of course to most men, startle him into wonderment. Why does the spinning top not fall? Why do animals breathe faster when they run? Why does disturbed water take the form of waves? Why do roots grown downward? Why does the mouth become dry when one speaks in public? Such are the questions that arise. The answers to them may be incalculably valuable to mankind. The microscope revealed to Pasteur strange organisms in bad-tasting wines. Why may not the disease of the wine, he asked himself, be due to the growth of these unusual germs within it? And later when he found germs also in silk worms, the further question was suggested, Why may not animals likewise become diseased in exactly the same manner? Whether the surmises of the investigator are true, the testimony of other men usually does not tell. He must turn to nature herself and put the idea to the test of observation and experiment.

This process of scientific inquiry involves peculiar qualifications which can not be disregarded by any one who thinks of trying it. Research implies in the first place *seeking again* over a region which has been previously traversed in order to learn what other men have done and the point where their labors ended. To make progress sure, therefore, previous records must be carefully studied. The failure to pay this just tribute to those who have labored before has not seldom led to fruitless effort or to vain repetition of work already well done. Marking the boundaries demands, then, a scholarly acquaintance with earlier discoveries; and the painstaking methods of the scholar must be used.

An ingenious and inventive imagination is a second requirement. It serves to indicate where the problems lie and also to suggest possible methods for solving them. The mind must be hospitable to all ideas thus presented, and yet it must receive them with skeptical scrutiny. By critically considering a plan for solving a problem it is often possible to select central tests, which are strategically related to the logic of the entire research. The physiologist Goltz is said to have done his most important work while fishing, for he employed that time in devising the crucially significant experiments.

Not all inquiries, however, can be ended by a relatively small number of crucial tests. Some investigations, like the important breeding experiments of de Vries, require years before they can be brought to a conclusion. Patience and an enthusiasm which is intelligently persistent are therefore essential qualities for the man in quest of new truths. The hopeful spirit is especially needed when, at the end of a long search, the investigator finds that he has only his labor for his pains—when his leading idea has proved to be false. That disheartening event is what Huxley called the tragedy of science—"the slaying of a beautiful hypothesis by an ugly fact."

The very soul of research, finally, is the highest degree of honesty. The investigator should see clearly and accurately with

an eye single to the truth. He has to consider not only the observations which fit his theory, but any others as well. The erratic cases invariably make trouble, but they are often disguised blessings. They may indeed be of far greater moment than those which have been anticipated, for they may point the way to entirely unsuspected facts. In my early studies on digestion I well remember how much I was annoyed by the repeated failure of some animals to show any signs of digestive activity during the period of observation. You can imagine how suddenly my vexation changed to deep interest when the troublesome inhibition was found to be an accompaniment of fright or anxiety which these animals showed while being looked through with the X-rays.

After the investigator has completed his examination of a group of questions which have interested him, his leading idea, his tests and his results must be described with scrupulous exactness. In thus reporting his work he should strive to be like clearest crystal, receiving the light and transmitting it untinged by any trace of color.

Scientific activity implies, of course, thorough disinterestedness. The investigator asks no favors and renders none. Any intimation that he act as a retainer or special pleader, any hint or suggestion that he restrict his explorations within certain limits lest he injure cherished traditions, is a step towards the confinement of the free spirit of intellectual inquiry. Rather than surrender that freedom of inquiry or the right of untrammelled announcement of fresh discoveries, men of science have in the past submitted to tortures and painful death, and you may be sure that, if need be, they will be ready to sacrifice themselves again. So exalted is the regard in which the man of science holds the ideal to which his life is devoted that he would find in these words of Fichte his solemn pledge:

> To this I am called, to bear witness to the Truth. My life, my fortunes, are of little moment; the results of my life are of infinite moment. I am a Priest of Truth; I am in her pay; I have bound myself to do all things, to venture all things, to suffer all things for her. If I should be persecuted and hated for her sake, if I should even meet death in her service, what wonderful thing is it I shall have done—what but that which I clearly ought to do?

The satisfactions of a life devoted to investigation, like the satisfactions of other careers, arise from the profitable use of one's powers. The peculiar powers which are needed for research I have just described. The employment of these powers in perfect freedom, and the immeasurably important results that flow therefrom, render the satisfactions of productive scholarship especially keen. These satisfactions we may now consider in relation to the special qualifications of the investigator.

The requirement that the investigator learn what other men have done before him in the field he seeks to enlarge gives him an unusual realization of the part he may be playing in the promotion of natural knowledge. Knowledge grows like the picture in the dissected puzzle. Every addition must fit the parts already arranged in order to possess significance, and also every addition makes possible the fitting of new parts whose positions in the enlarging picture become thereby suddenly revealed. One of the delights of research, therefore, is the sense that every bit of new knowledge finds its place in the structure of truth, and that sooner or later it will be required for the further building of that structure. The relation which the fresh contribution bears to that already established, the discoverer clearly sees; what relation it will certainly bear to further

contributions he may never know. How little did the men who studied the minute differences among mosquitoes, and who recorded the breeding habits of those insects realize their important rôle in abolishing the pestilence of yellow fever, and in bringing about the immense social and political changes which will result from that conquest.

Because every discovery becomes the basis for further discovery the imagination of the investigator is constantly stimulated. New facts suggest in turn other facts and point to unsuspected relations between things that have long been known. Bayliss and Starling's discovery of a natural chemical stimulant which induces secretion of the pancreas led directly to the explanation of continued gastric secretion, and also to finding the marvelous mechanism by which the mammary glands are prepared for the giving of milk. Thus, though the interests of the man of science seem at the moment narrow and restricted, they may nevertheless lead his thought out into many diverse realms of knowledge. These excursions of the imagination offer repeated suggestions for fresh adventure. The look therefore is always forward to what may be seen when the next step is taken. Seeking new things becomes in time a fixed habit. Past achievements neither satisfy interest nor hold attention —they become fused with the established routine from which it is a happiness to escape. The chance of beholding unsuspected wonders, or the possibility of finding that something imagined is really true is a constant incitement to further search and furnishes the zest and interest which are among the best rewards of the investigator.

Much happiness is found also in that single-mindedness, which, as we have seen, is one of the prime conditions in the pursuit of knowledge. It implies freedom from bigotry and prejudice, freedom from many of the influences and motives that to their regret men feel compelled to respect for purposes of prudence or policy. The intrusion of any other motive, save that of discovering and telling the truth, only tends to distract the mind of the investigator from his absorbing work. Faraday, whose life as a man of science was near perfection, wrote:

> Do not many fail because they look rather to the renown to be acquired than to the pure acquisition of knowledge and the delight which the contented mind has in acquiring it for its own sake? I am sure I have seen many who would have been good and successful pursuers of science and have gained themselves a high name, but that it was the name and the reward they were always looking forward to—the reward of the world's praise. In such there is always a shade of envy or regret over their minds, and I can not imagine a man making discoveries in science under these feelings.

Single-mindedness involves also a relative indifference to those motives of money-getting which prevail in commercial life. Success in research is fortunately not measured by money standards. And yet research flourishes best where there is free time to spend in thought and experiment. This time element is essential. The investigator may be made to dwell in a garret, he may be forced to live on crusts and wear dilapidated clothes, he may be deprived of social recognition, but if he has time, he can steadfastly devote himself to research. Take away his free time, and he is utterly destroyed as a contributor to knowledge. Free time and absence of the money motive, however, are found together only among the indolent poor and the indolent rich; and the observation has been made that neither of these classes is likely to contribute men of science. The industry of the investigator which results in new knowledge—knowledge in its unprofit-

able infancy—does not possess commercial value. Until recently indeed any money value of research had not been recognized. In the unappreciative past deplorable instances were known of struggles with poverty and want, going hand in hand with persistent loyalty to truth-seeking. Now, however, accumulated wealth is giving leisure for men to carry on their investigations free from the worries of uncertain livelihood. What they receive may not be much, but it is sufficient to permit them to look upon the scramble for wealth without envy or regret.

Fortunately, the provisions which enable men to pursue careers in science are found mainly in great universities, through which a stream of youth is constantly passing. There men who are moved by the instinct of investigation usually find their most congenial surroundings. Freedom of inquiry is the ancient tradition of the university spirit, leisure is recognized as a requisite for meditative observation, and the youth who resort to these centers of learning can be awakened to wonder at nature's hidden secrets, and can be stimulated to undertake with ardor the struggle to possess them. The peculiar richness of university life flows from memories of the transforming powers of the progressive and original minds who have by their eagerness for the truth and their freedom from worldliness inspired their students with their own ideals.

The greatest compensation, after all, for the truth seeker is the discovery of the truth. The value of labor that brings a revelation of new knowledge does not cease with the day; it remains as a permanent acquisition for the race. There is really great satisfaction to the investigator in this thought of the "durable results of the perishable years." But not only because of the permanence of truth is there pleasure in discovery—it is the marvel of beholding for the first time an unknown aspect of nature that fascinates men of science, and through difficulties and repeated disappointments holds them to the search. Only he who has had the experience knows the thrill that comes when that which was imagined proves to be true. One who was in Faraday's laboratory when the influence of the earth's magnetism on a wire conducting an electric current was first tested, has written: "All at once Faraday exclaimed, 'Do you see, do you see, do you see!' as the wire began to revolve, and I shall never forget the enthusiasm expressed in his face and the sparkling in his eyes." Kepler knew the joy which rewards the scientific discoverer when he completed the evidence that established his third law of planetary motion. Even one whose pulses have not quickened with the excitement of discovery can understand perhaps how he must have felt as he burst into triumphant exultation:

> What I prophesied two-and-twenty years ago, . . . what sixteen years ago I urged as a thing to be sought, . . . that for which I devoted the best part of my life to astronomical contemplations, at length I have brought to light and recognized its truth beyond my most sanguine expectations. It is not eighteen months since I got the first glimpse of light, three months since the dawn, very few days since the unveiled sun burst upon me. Nothing holds me; I will indulge my sacred fury. If you forgive me, I rejoice; if you are angry, I can bear it. The die is cast, the book is written, to be read either now or by posterity, I care not which. It may well wait a century for a reader, as God has waited six thousand years for an observer.

The scientific investigator may not seek particularly for knowledge which can meet at once some material need. Like the artist, he is more prone to direct his efforts towards that which will for the moment properly gratify an absorbing interest of his mind. If the new knowledge has,

when discovered, an immediate practical value, so much the better; but the direct search for understanding has certainly always proved the most effective motive in scientific labors. Because of this attitude the investigator should not be regarded as self-centered, or neglectful of duties to the general good. He is serving best his own generation in so far as he makes his standard of work thorough and honest. In so far as he does that, he is serving best future generations as well, for only thus can the results of his work be used later as a basis for further advancement. And since the interrelations of phenomena are so manifold the conviction is justified that every bit of honest work can finally be utilized in forming the body of truth. Although the investigator may labor, therefore, primarily to satisfy his own curiosity, and to secure for his craftsmanship that inner approval sought by every conscientious worker, neverthless he is making permanent additions to the world's values. There is about his life, as Professor Royce has noted,

> an element of noble play. . . . One plays with silk and glass and amber, with kites that one flies beneath thunder clouds, with frog legs and with acid. The play is a mere expression of a curiosity which former centuries might have called idle. But the result of this play re-creates an industrial world. And so it is everywhere with our deeper curiosity. There is a sense in which it is all superfluous. Its immediate results seem but vanity. One could surely live without them, yet for the future and for the spiritual life of mankind, these results are destined to become of vast import.

Sometimes the worker in science lives to see his services used for the relief of human need. When Davy's studies of combustion enabled him to invent the safety lamp, he gave the invention freely to the world. He knew then that thenceforth for all time toilers in the mines could protect themselves against the dangers of destruction. There is no realm, however, in which the deep satisfaction of seeing discovery applied to human service is more likely to be experienced than in the realm of medical research. Consider how great must have been the joy of Pasteur and of Lister when they realized that the consequences of their investigations must lessen forever plague and pestilence and pain in men, and in the lower animals as well, and must permanently remove much of the blind struggle against mysterious agencies of disease and death. The letter which Walter Reed wrote to his wife on New Year's eve, 1900, at the end of his experiments on the transmission of yellow fever, tells something of the joy of such service—"The prayer that has been mine for twenty years," he concludes, "that I might be permitted in some way or at some time to do something to alleviate human suffering, has been granted! A thousand Happy New Years." And a thousand happy new years there will be for thousands of men and women and children, because of that one research in Cuba.

Through the employment of methods of scientific inquiry to medical problems more progress has been made during the past sixty years towards an understanding of the nature of diseases and their control than had been made in the previous twenty-three centuries. Think for a moment of what has been learned about diphtheria and tetanus, about meningitis and rabies, about tuberculosis and syphilis, about dysentery and cholera and typhoid fever. How fundamentally our attitude toward these diseases has altered as the discoveries of medical investigators have given us insight and powers to control. What great progress we have already made in this relatively short period towards the relief of man's estate. Still we must not forget that there are immense labors yet to

be accomplished. We are yet surrounded by innumerable mysteries, which can only be solved by persistent research. Not all men are fitted by temperament or training to engage in this great work, but more are thus fitted, I am sure, than are awakened to its opportunities. For those of you who are ready, here is a challenge to the supreme use of all your powers—to your imagination, your ingenuity, your patience and enthusiasm, and to your spirit of disinterested service. W. B. Cannon

Harvard Medical School

THE CONDUCT OF THE BUREAU OF CHEMISTRY

The committee on personnel of the department of agriculture, composed of W. M. Hays, assistant secretary; George P. McCabe, solicitor, and C. C. Clark, chief clerk, have made to the secretary of agriculture a report on the engagement of Dr. H. H. Rusby as pharmacognosist in which they come to the following conclusion:

That Drs. Wiley, Bigelow and Rusby, throughout the negotiations for the readjustment of Dr. Rusby's salary, had in view the purpose to restore Dr. Rusby's rate of compensation to $20 per diem for days actually employed, thus to retain his expert services both in the laboratory and in court, which services were highly valued by the Bureau of Chemistry; to accomplish this purpose they made a secret arrangement, and, through Dr. Wiley, proposed to the Secretary of Agriculture the appointment of Dr. Rusby at a legal rate per annum, without disclosing to the Secretary that Dr. Rusby was in fact to be paid at an illegal rate, different from the rate specified in the appointment.

Based upon this report, the committee submits the following recommendations:

1. That Dr. H. H. Rusby, pharmacognosist in the Bureau of Chemistry at $1,600 per annum, be dismissed from the service, on account of irregularities in connection with his appointments and recommendation for appointment of Dr. William Mansfield as unskilled laborer.

2. That Dr. L. F. Kebler, chief of drug laboratory in the Bureau of Chemistry, be reduced from his present position as chief of the drug laboratory to a position and status in which he will have no authority to make recommendations regarding the salaries or periods of service of other employees, on account of irregular conduct in procurement of services of Dr. H. H. Rusby.

3. That Dr. H. W. Wiley, chief of the Bureau of Chemistry, and Dr. W. D. Bigelow, assistant chief of the Bureau of Chemistry, be given an opportunity to resign from the positions which they now hold in the Bureau of Chemistry, on account of irregularities in appointments of Dr. H. H. Rusby.

The attorney-general has recommended to President Taft the approval of the findings of the committee. It does not, however, appear to be likely that President Taft will dismiss Dr. Wiley, Dr. Bigelow and Dr. Rusby, for an alleged technical violation of the law. Dr. Rusby is a botanist and student of materia medica of high distinction and dean of the College of Pharmacy of Columbia University. If he was employed at a salary of $1,600 a year by the government, it was known to every one that he did not devote his entire time to government work. Dr. Wiley should be reprimanded if he has permitted a technical violation of the law, and the law should be altered so that scientific experts can be employed by the government on part time at a reasonable salary. And the president and the congress may very well take the opportunity to express their appreciation of what Dr. Wiley has accomplished for the public health.

SCIENTIFIC NOTES AND NEWS

Professor L. H. Bailey has tendered to the trustees of Cornell University his resignation as director of the New York State College of Agriculture. He has made no public statement about the matter except to admit that it is his intention to retire from teaching.

Surgeon-General Wyman has appointed Dr. E. C. Franklin, since 1903 professor of organic chemistry at Stanford University, to be professor of chemistry in the hygienic laboratory of the Public Health and Marine-Hospital Service.

The director of the Museo Nacional, Mexico, Sr. Garcia has resigned and Sr. Robelo