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CONTENTS

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RESEARCH AS IT IS TO-DAY[1]

LET my first words carry my warm gratitude for the kind and friendly thought which prompted the Johns Hopkins University to invite a French professor to speak here to-day. The Paris University, as the oldest in the world, feels itself to be, as it were, the grandmother of all others. This time-honored old lady is happy to see one of her younger offspring cheerfully celebrating her fiftieth anniversary. I am glad to bring you her most cordial congratulations and wishes.

For my part, I do so with all my heart, and I share in this beautiful celebration more as a friend than as a guest. It always seemed to me that some special affinity exists between the American and the French mind. I myself am quite at home among American fellow-workers, so easy is mutual understanding. I had this experience more than once; and to-day, on this unique occasion, amidst this unequalled audience, I feel it the more deeply.

Fifty years: only a start, a mere beginning in the career of a spiritual being like Johns Hopkins. Still how many valuable services have already been rendered to science and learning by this university! What a roll of glorious names it can show! To enumerate them does not belong to me. Better informed men are required to record that history. But I can not refrain from mentioning at least a few of the most illustrious men of science and scholars whose teaching and discoveries, from the first, established the prominence of Johns Hopkins: Ira Remsen, the chemist, whose admirable life has just been so vividly depicted before us; the far-famed physicist Rowland; for biology, Brooks; for medicine, Osler; for semitic studies, Bloomfield; for classics, Gildersleeve; and so many others whom I regret not to be able to mention in this address!

That so many eminent men met and worked here, during so short a lapse of time, that they made the name of Johns Hopkins renowned in Europe as well as in America, can not be attributed to chance. Obviously there were reasons for this luxuriant blooming of the new-born university. Under the guidance of its first president, Daniel Coit Gilman, Johns Hop-

[1] Address delivered at the fiftieth anniversary celebration of the Johns Hopkins University, at the exercises commemorating the opening of the new building of the School of Hygiene and Public Health, on October 22, 1926.

kins was at once organized "not so much for the purpose of passing on the rich heritage of past knowledge, as to discover new truth, and thereby extend the frontiers of the human mind." Conscious of the manifold aims it had to pursue, Johns Hopkins clearly conceived that the most important, the most vital and capital aim, which preceded all others, was the promotion of research. And not only it conceived it to be so, but it proceeded to act on this idea. Here lies the actual distinction and excellence of Johns Hopkins; here, the secret of its rapid rise and the promise of its future achievements.

Research, like many other human activities, has undergone some change in our modern world. It is no more the occupation of a few lonesome people. It is unceasingly going on in numberless institutes and laboratories, and its results fill a formidable array of periodicals. Thousands of men and women are working under all latitudes, from the Arctic Circle down to New Zealand. All have a claim on our esteem and praise, since every one, even the most pretentious, enlisted on science's service, devotes to it whatever ability and skill he or she possesses. But evidently all kinds of research do not stand on the same level. A great many laboratories are appropriated for the advancement of what the Germans call *die Technik*, that is to say, the most satisfactory combination attainable of practical aims and scientific means. Our arts and manufactures are continually confronted with many problems which are amenable to this research, some of a very wide range, others more or less narrow. Suppose, for instance, the remaining quantity of coal in the world was known and likely to be exhausted in a given number of years, the question is to discover a substitute for it and meanwhile to find out the best use we can make of it. The same problems arise for oil and all the valuable materials which mankind, until now, really did not consume but wasted.

This kind of research chiefly aims at a rational employment of the natural resources at our disposal. It has proved faithful and is well worth the united exertion of a host of investigators. It permits a division of labor; such problems may often be divided into more and more minute questions which, in order to be solved, require only time and painstaking and professional skill. In some branches of the chemical industry, scientific research may be said to be in reality "taylorized."

On a different and somewhat higher plane, another kind of problem appears which is not properly technical, although forced upon us by actual and sometimes dire necessities. Here trustworthy methods, skill and a staff of experienced workers can no longer suffice. Something more is required, which only an inventive turn of mind is able to afford. Shall I report a striking case in point? About sixty years ago, the Rhone Valley in France was threatened with an awful calamity. An unheard-of disease was killing the silkworms, and the silk industry was on the verge of destruction. No remedy could be found: what was to be done? As a last measure, the despairing people resorted to the great biologist Pasteur, entreating him to try and save them. He consented to study the problem. After several months of strenuous work, which endangered his life, he fortunately discovered the cause of the disease and at the same time the means to prevent it. Thus the silk industry was saved.

Although in this fight with immediate problems we are far from always getting the better of them, it is worthy of note that men of science never lose heart. Failure is only an incentive to try again. When research has made sufficient progress, they even take the offensive, and move forward to the extermination of the worst scourges of human life. Who can forget how yellow fever was wiped out of Panama and Cuba? How malaria is victoriously contended with in many countries? Against tuberculosis and cancer, here, as in Europe, a holy war is being waged, and there will be no armistice until the foe is done away with.

Such researches deserve the attention of the clever men and women who give themselves up to it. They make life easier and more bearable for all. They often succeed in allaying the pains of those who suffer, and occasionally defeat "immature death," which the Latin poet Lucretius bewailed, thinking that it was not ever possible to beat it back. It sometimes happens that they lead to capital discoveries. Nobody would grudge the praise, the credit due to them. Yet it must be admitted that what they aim at, and often achieve, is an extension rather of our power than of our knowledge. They do not very often open new vistas for science. They do not help very much to make us better acquainted with the secrets of nature and the intricacies of phenomena.

To investigate the latter is the exclusive object of still another kind of research, which tends to pure science. Its only aim is the discovery of truth, without any reference to actual needs. Its problems are not propounded to or thrust upon it by practical necessities. They emerge from the present state of the sciences at every moment. Each new discovery is but a stepping-stone to higher questions; for what pure science endeavors to gratify is an unquenchable thirst for more knowledge. This pursuit of scientific truth for the sake of truth itself, and nothing else, may be called the highest form of research. It is research *par excellence*. Historically, it was the origin and the real

nerve of all other kinds of scientific research. It gave them their life and nourishment. Failing this genuine craving for truth, failing pure theoretical research, all applied sciences would be doomed to deteriorate and perhaps sooner or later to end in mere empiricism.

Fifty years ago, when Johns Hopkins was founded, there was little need to voice these almost self-evident notions. To-day they are somewhat obscured, in consequence of the very development of both theoretical and applied sciences. We have beheld a splendid advance in physics, in chemistry, in biology, not to forget the vast realm of mathematics. This progress, in its turn, has made possible the marvelous conquests of applied sciences. Then such has been the profit and the renown of these latter that theoretical sciences find themselves a little in the shade.

No one is responsible for this inversion of values. In the present state of affairs it was not to be avoided: so many causes were leading to it. Pure theorists are fewer and fewer, compared with the growing number of workers in applied sciences. Beautiful discoveries in abstract sciences are nearly always out of the reach of the uninitiated, while achievements in applied sciences not only happen much more frequently, but also strongly appeal to the public imagination. And they seem to be so much more profitable! Every man in the country can appreciate the benefit of the wireless, the airplane and so many astounding inventions—incredible wonders for our parents, commonplaces for our children. But how few can perceive that the recent discoveries pertaining to relativity, atoms, radioactivity and so on are more momentous and of wider consequences. Yet nothing is more true, and perhaps it is not untimely that public opinion should be reminded of it.

It was said, long ago, that when the first Greek geometricians were studying the conics, nobody could have the faintest idea that, many centuries afterwards, the purely theoretical truths they were digging up would save innumerable sailors' lives. Before them, Egyptians had arrived at some technical knowledge in geometry and mechanics, of which they availed themselves to build their temples and pyramids. But, as Plato says, with some irony, that was a science of merchants, not of geometricians. To be sure, it could never have led either to astronomy, such as the Greek created it, as Copernicus, Kepler, Newton and Einstein enlarged it, or to the physical and biological sciences such as we possess to-day. Consequently, had not the Greek philosophers, mathematicians and physicists been at work, the whole of the applied sciences, which our civilization boasts of so proudly, would have remained non-existent and not even imagined. All our engineering, all the huge mass of our multifarious industries has its root in the disinterested and purely theoretical research of a few men of sciences in a petty corner of the west, some twenty-four centuries ago. To their more practical contemporaries, very likely, they cut the figure of dreamers, queer and harmless people, idly poring over meaningless lines and figures. Thus history warns us against the temptation and danger of rating the rank and value of the various kinds of research according to their immediate and apparent usefulness. Ought even utility be our standard at all? Aristotle thought that metaphysics was the most beautiful of sciences, because the most useless. Had he known of our pure mathematics, physics, chemistry and the rest of our theoretical sciences, he would not have debarred them of a similar praise. Disinterested pursuit of truth, untiring struggle with the mysteries of nature are the lasting honor and dignity of our species. To give them up, even if they were practically useless, would be tantamount to losing what in us is preeminently human.

But indeed pure science, far from being useless, is generally sure to become, in the long run, the most useful of all. When an invention, either big or small, comes forth, we may, without much difficulty, calculate what is to be gained by it. But when new laws of phenomena are disclosed, when, for instance, radium is discovered, who can guess at once the far-reaching consequences, and what other discoveries may follow, adding unexpected provinces to our empire over nature? The potential utilities of disinterested research are unbounded and at first unmeasured. Therefore, though the most abstruse and theoretical science looks sterile, it is not. Likewise, snow-clad peaks and lofty ranges seem to be barrenness itself. Yet therefrom mighty rivers take their rise, and to their waters the rich lowlands partly owe their fertility.

So it was an unerring instinct, or, better said, a far-reaching insight, which led the Johns Hopkins to assign to itself as its goal research under its various forms, and more especially pure science.

It is evident that such a place must not be crowded and should be more of an assembly of seminaries than of a complex of large colleges. However interesting and clever lectures and courses may be, the young adepts in sciences, the physicists, chemists, physiologists, etc., in the making, do not want to sit at them by the hour. They have entered another period of their training. What they must get now is personal intercourse with the leading men of their science, in order to partake of their daily work in their laboratory or library. As they are in the process of evolving from pupils to fellow-workers, such an intimacy with the masters is the sole teaching they need. In this way they will acquire not only accurate knowl-

edge, the habit of strict reasoning and the distrust of too easy and delusive explanations, but also, and above all, the craving for new truth, and that polarization of the mind, if I may say so, which shapes it into a fit implement for research and discovery.

Some—indeed very few—are born men of science. Others achieve such a vocation; only they must be helped to it. Scientific genius appears where and when it pleases. Nature is not prodigal of wonders like an Archimedes, a Newton, an Einstein. All we can do is to look up to them as they shine and to give them any means of work they may want. But nature also brings forth, in every age, a variety of original and productive minds, which, though no stars of the first magnitude, are capable of contributing to the advancement of sciences. These must be encouraged, informed, developed in a congenial atmosphere. It is for such young men that a university like Johns Hopkins seems designed.

Were the spirit of disinterested research to get strength, we might hope to see it gaining new ground, and more and more penetrating the study of a wide range of phenomena which, hitherto, have been the object of an immense amount of labor, but not in the same way as men of science are wont to work. Up to this day, moral and social sciences have hardly been sciences, in the strict sense of the word. Many reasons explain the fact, and, in the first instance, the peculiar nature of their subject-matter must be taken into account. Wherever human interests, feelings and passions are directly involved, the serene objectivity which science can not do without becomes exceedingly difficult to attain, and, when attained, to keep up. Mostly the conflict of opinions, either outspoken or tacit, makes the unbiased analysis of facts a sheer impossibility. Had mathematics, in the eyes of men, the same kind of interest as politics, perhaps mankind would never have known what truth really is. Who would gainsay this deep thought of Spinoza? Let us rather go to the bottom of it, and say, in our own turn, that not until we look at social facts as we do at physical ones, shall we discover scientific truth about them. Certainly molecules, cells and the like are more easily viewed with dispassionate eyes than labor problems or competition between nations. Still, should the spirit of disinterested research get a firm footing here, we might expect much from its efficiency.

Until now, human communities have had to be content with the traditional wisdom and ability of their leaders. However gifted and clever these may be, their empirical skill can not in every case make good the deficiency of scientific knowledge. Under very unusual circumstances they may be baffled, and out of their depth. Then highly civilized nations grope in the dark and blunder into hateful wars. It is generally said that blind collective impulses are chiefly responsible for that horror. Granted; but ignorance has its share in it and keeps the passions alive. Perhaps, when Johns Hopkins celebrates its thousandth anniversary—if it is not too bold to anticipate so much—people will at the same time admire and pity us, supposing they think of us at all: admire what our time achieved in abstract and applied sciences, but pity our astonishing ignorance of the laws of social phenomena and the loathsome evils we are consequently muddling through.

Can a stronger reason than this be conceived to keep up the spirit of disinterested research, to shelter and to defend it against any danger that might threaten it? Extreme poverty is fatal to it; wealth has also its drawbacks. Shallowness is irreconcilable with the true spirit of research, but a too narrow specialization may smother it. The latter hinders the soaring of the imagination and discourages the daring necessary to the seeker for new truth. If his eyes remain servilely riveted on a given series of facts, he has little chance of rising to an unexpected hypothesis, which generally should imply the bringing together of facts hitherto considered apart. To this the history of sciences testifies. As often as not, original discoveries are due to men whose work had begun in another field. Pasteur, for instance, if I am allowed to name him again, who originated a momentous revolution in pathology and therapeutics, had not graduated in medicine. He started with merely chemical researches and was led by degrees to his famous biological discoveries. Thus every one of the young pioneers of science ought to be enabled to dig his own hole and at the same time to survey the surrounding ground.

I can not attempt here to draw even a summary sketch of what the education of an ideal man of science should be. Yet there is still something that must not be left unsaid. I conceive him to be a man of his own time and rather a harbinger of the coming age than a representative of the bygone ones. He is also to be thoroughly human, and therefore never exclusively engrossed by his own special work, though he gives it his days and sometimes his nights. I see him eager for every noble cause, responsive to the great calls of his age, and endowed with a beautifully furnished mind. He is no stranger to the invaluable treasures which the ancients bequeathed to us. Their poetry, their philosophy appeal to him. He finds therein a matchless refreshment, which makes him the more keen-witted, the more clear-sighted for his own investigations.

This is no fanciful picture. I have an actual model for it in my mind's eye. I mean that admirable man

of science, Sir William Osler, whose spirit animated a part of this university and still lives in it. Never was a man more completely devoted to his chosen research; and yet, how alive to the moral needs of his contemporaries, how full of human kindness, how intimate with classical and modern poets! May many such accomplished men of science meet in this university so fit to welcome them, may many rise out of it, doing good service to mankind and honor to their country!

L. LEVY-BRUHL

UNIVERSITY OF PARIS

THE MEDICAL SCHOOL A PROFESSIONAL SCHOOL OF SCIENCE[1]

THE zero hour has come. At least, being no orator, I have much the feeling usually attributed to that momentous occasion. Selected on the basis of seniority and obedient to command I extend the call to medical graduates to go over the top in a new advance in the age long war of experimental science against credulous adherence to tradition. In this war it was the privilege of the Johns Hopkins University to establish the first school for officers in this country and thus to make a new declaration of independence one hundred years after the first, a declaration of intellectual independence.

Her graduates have gone to all parts of the country to aid in the development of American universities as institutions for the advancement as well as the diffusion of knowledge. Many of these graduates have returned here to-night to celebrate the fiftieth anniversary of their alma mater and at the same time to bring with them the cordial greetings of the institutions with which they are now connected. These institutions are so numerous that a personal public tribute from each is impossible at this time. I therefore desire to extend in behalf of the medical graduates engaged in teaching the heartiest expression of good will from their respective faculties.

As an example of the kind of tribute which each would like to pay if time permitted, I desire personally to extend the greetings of the university with which I have been connected during the past twenty-two years, the University of Wisconsin. During the early years of the Johns Hopkins University, Wisconsin, then essentially a college, sent many of her graduates here for advanced training. During the eighteen-nineties Wisconsin became a university by developing extensive facilities for graduate work and research. In the process of university development Wisconsin called upon the Johns Hopkins for numerous leaders, including such men as Richard Ely and W. A. Scott in economics, Moses Slaughter in Latin, Charles H. Haskins in history and Joseph Jastrow in psychology. Some of her own alumni who took a leading part in this university development, such as Frederick Turner in history and H. L. Russell in bacteriology, had graduate work at the Johns Hopkins. Robert Wood, trained here, made his mark at Wisconsin before returning to continue a brilliant career in physics. When the medical school at Wisconsin was established early in the present century, the Johns Hopkins Medical School was called upon to furnish men to head several departments. The furnishing of leaders for educational advance has not, however, been entirely one-sided. Wisconsin was called upon to sacrifice Carl C. Thomas when the Johns Hopkins established the school of engineering and E. V. McCollum when the Johns Hopkins established her School of Hygiene and Public Health.

Many similar illustrations might be given of what the Johns Hopkins has meant to other institutions during the past half century. To use a medical metaphor, she has been a thyroid gland, the products of which at first helped to ward off cretinism in our institutions of higher learning and to-day help to ward off myxoedema.

I am asked to-night to discuss the next half century of the university from the standpoint of the medical school. Unfortunately, I am not only not a prophet, I am not even a clinician accustomed to giving professional prognoses properly protected. Were I to regard myself as a clinician of medical institutions, I should have to regard myself rather in the light of an obstetrician and pediatrician than in the light of a geriatrician to be called in to give a health examination to a lusty individual of fifty whose only complaint appears to be a tremendous appetite, and whose ideas of a balanced diet are millions for philosophy against millions for medicine.

The success of the Johns Hopkins during the past fifty years, however, has been due not to abundance of material resources but to adherence to ideals, to vitamins rather than to calories. Among the more important of these vitamins I take to be:

Vitamin A: Let practice preach.
Vitamin B: Live leaders, not monumental mortuaries.
Vitamin C: Achievement, not acquirements.
Vitamin D: Individuality, not institutionalism.
Vitamin E: Service to science, for light not lucre.
Vitamin F: The future foremost.

These vital principles we all desire to see continued during the next fifty years, however the course of our civilization may trend. It may pay us to consider each a little more in detail to illustrate its meaning.

[1] Address delivered at the fiftieth anniversary banquet of the Johns Hopkins University, October, 1926.