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THE RESEARCH SPIRIT IN MODERN LIFE[1]

FOR four years, living in this delightful community, under the guardianship of this great institution, participating in its benefits, drawing from its rich sources of supply, both material and intellectual, you young men and women have been through a process of development that marks a most important stage in your life career. But to-day we may not look only upon the memories of the past four years, but with janu-form vision look forward as well and realize that we are at the commencement of a long period of life, for the most part, alas, unprotected by the motherly arms of the university and the cooperative efforts of class, fraternity and sorority mates.

It is indeed the unusual undergraduate who senses the true privilege that he is enjoying by life in this community. The money he contributes is but a small fraction of the cost entailed in providing the educational facilities here to be found. Everywhere about this campus there are evidences of the munificence of the state, the town and those who have passed on and who in grateful memory of what they have received here have attempted in manifold ways to repay their debt.

Laboratories, libraries and indeed fraternity and sorority houses are all evidences of the appreciation of those who have stood exactly as we are standing on this eventful day, many years ago. For four years this campus has seen you all, going hither and thither, each occupied with his or her problem, but each necessarily, perhaps subconsciously, mindful of the community's welfare. While everywhere one finds that freedom of action and freedom of speech have been encouraged, nevertheless no man can assert his rights if those rights are not sane and unobjectionable to the majority of his classmates, for with freedom of speech comes responsibility and weighing of words. So college life has taught us that each, personally, must have the welfare of others at heart.

The underlying spirit which has so coordinated the entire community life and has made for betterment of the moral and physical and intellectual body has been that of trying, experimenting, proving, developing, for progress even in the smallest degree can only be made or attained by experiment, although with a community as large and with the wide diversity of interests as is here found, obviously much of its life rules and principles must have been preformulated.

[1] Commencement address given at the University of Maine on June 9.

Nevertheless a moment's reflection will show that this university is by no means the same university that it was four years ago, when you entered it. Even in this brief span of time there have been most profound changes. I am not speaking solely of the material but chiefly of the intellectual, the habit of thought and the line of reasoning, all of which are produced by an unceasing development of the spirit of unfolding, searching for the new, proving, testing. This spirit we may properly call the spirit of research. The common use of the word "research" which is so often, in my judgment, erroneously confined to the research and study for material development fails to express the broader and cultural significance of the word.

Individual effort, though the basis of all research, must be directed not to selfish but to communal welfare. Prehistoric man could advance but little as a single member of society; he could alone make but feeble headway against the vicissitudes of life, but the clan and the patriarch, with his family gathered about him, moved and worked all in the interests of the group. The needs of early man were few, and it was only slowly (perhaps in time reckoned in thousands if not in tens of thousands of years) that the simplest commodities became available to him. Thus fire, that greatest agency for the development of mankind, came into the hands of primitive man very late and probably as a result of accident. No other single agency made possible such fundamental alterations in primitive man's whole method of living. His first knowledge of it was undoubtedly the aftermath of the thunderbolts, and lightning flashes, with devastating forest fires, which filled him with great terror. Far from being inclined to duplicate these frightful events, he would seek to avoid contact in any way with such an agent, and it is rather difficult to imagine that the cave-dweller realized the development of heat by friction, the sparking of flint and ignition therefrom, or the concentration of the sun's rays by means of a spherical mass of crystal or of ice, so in all probability this great asset came to man as a result of accident.

Controlled fire with its incalculable advantages is probably the best example of man receiving into his hands by accident mastery of one of the greatest forces of nature, and yet we may possibly be doing injustice to some mute, inglorious Franklin, who by some subtle spark of genius and thought may have planned simple tests or efforts to secure this commodity. One could almost wish that one could be assured that such were the case, for it is a fact, at the present date, that additions to our knowledge, proving of material value to the world, are rarely the result of accident but are usually the end-result of a long, painstaking series of carefully developed plans and concentrated efforts upon a pre-conceived and hoped-for end. Undoubtedly when one considers the innumerable inventions of the present day, *some* were the result of accidental findings, but few, if any, great discoveries are based upon accident, for a great invention is one that involves utilization, classification and interrelation of one or more great basic principles upon which all our material progress is founded.

It is this method of attack that is exemplified in its highest form in research. With each new development there accumulates with almost geometric ratio a widening of activity, control of forces, utilization of powers formerly undreamed of. Without doubt our cave man immediately applied his control of fire to the preparation of foods, thus resulting in altering his diet. It made possible his excursions into colder climates and it gave him an agent in combatting the maraudings of wild animals and, indeed, at times his fellowmen.

So with each research problem successfully completed at the present day our field of endeavor immediately widens. Franklin's daring in drawing electricity from the clouds with his kite but a little over a century ago has broadened now into such a diversity of uses of electricity that the mind staggers with its efforts even to classify them. And yet all this has happened within, relatively speaking, a few hundred years. It has been recently asserted that in all probability man in essentially an unaltered physical form will be upon this planet for not far from four or five million years. During this time there is no reason to suppose that there should be a cessation or retardation of progress, so that in a way we are simply at the threshold of human development, and while we find ourselves surrounded by all sorts of comforts and luxuries undreamed of, yet, as surely as we are here to-day, in 200 years we will be considered almost as a primitive people.

The side wheel steamer of 60 years ago is fast disappearing. Who cares or, indeed, *dares* to ride the high wheel bicycle, and Fifth Avenue is without its splendid horse-drawn equipages that dazzled the beholder by their luxury and elegance hardly 20 years ago. These are the effects. The cause is the development of research in transportation agencies, giving us the propeller, the modern bicycle and the automobile. These are all the result of *design* and not accident.

On one of those white marble buildings comprising that magnificent group of research centers at the Harvard Medical School there is a tablet showing that this particular building was the gift of Mrs. Arabella D. Huntington in memory of her husband, Collis P. Huntington, the great railway magnate. Former President Charles W. Eliot, with his inimitable style, wrote for this tablet a few words which

embody so perfectly the spirit of research that they should be on the wall of every educational institution. The inscription reads: "Life is short and the art long, the occasion instant, experiment perilous, decision difficult." In no other way could one in so few words express the entire spirit of research, for this is really an epitome of the research spirit with the dominant note *design* and not accident. Let us read again this tablet. "Life is short." In the progress of science nothing could be shorter than life. When our paleontologists are discussing prehistoric man in the terms of tens of thousands of years and when our prophets are implying that we have still some millions of years to live, each of those organisms known as man has but a brief, transitory sojourn on this earth. What a depth of meaning there is in the expression "The art is long." What is more enduring than the art? And by the art one does not mean simply the esthetic expression of man's sublimest thoughts in the form of prose or painting or chiselled stone or monumental pile, but all that man can by skill, thought and plan contribute to civilization.

Again we read, "The occasion instant, experiment perilous." In these advancements which must inevitably continue with man's prolonged existence there are periodic instants where the occasion for observation, for test or proving may exist for but a very short time. To distinguish between the essential and the non-essential is one of the most difficult features in developing observational powers. The danger of not making the critical experiment at the proper time is indeed perilous, perilous to progress. The perilous nature of experiment rarely involves danger to the life of the individual making it, and yet history affords instances of such occurrences.

But when we think of the heroic tests of Major Walter Reed and his associates, when by submitting to the poisonous, death-dealing sting of that pestilential yellow fever carrier, the mosquito, they sacrificed their bodies on the altar of science, one can truly say that experiment is perilous.

The entire path of the research worker is strewn with difficulties, but, after all, the most difficult things are the best things, the things most appreciated, the accomplishment of which is accompanied by the greatest gratification. Difficulties begin immediately with the assessment of the values of earlier work, as to what is to be saved, what is to have bearing upon the new problem, and what is to be rejected. The experimental conditions, with their technicalities and niceties of adjustment, present further difficulties. The discrimination of the essential from the non-essential in observation next presents difficulties, and above everything else there is the greatest difficulty in interpreting results of experimentation, so that the words "decision difficult" are continually before the research worker.

True research must take into consideration past experience, a careful survey of what has gone before, with a particular view as to the correct path to follow, and *then* the attack upon the problem under investigation. Accident has little, if any, place in a research program. Yet at times there are of course fortuitous discoveries of wonderful importance. The great transcontinental railroads in cutting through a mountain are bent upon securing the most direct route of transportation, but do not the marvellous fossil remains accidentally uncovered in connection with their excavations unfold innumerable pages of past history? On the contrary, Benjamin Franklin's drawing electricity from the air during a thunderstorm with his kite and key was by no means an accident. Here we might well repeat Dr. Eliot's words, "The occasion instant, experiment perilous."

To what extent research enters into modern life can best be seen when one realizes that all our largest industrial organizations have definite sections devoting a large part of the time of a considerable number of workers to research, mainly, it is true, on problems of specific economic interest for the corporation. While of course many processes are retained as "trade secrets," a very large amount of the work is published and thus made available for all mankind. So important an influence upon the success of the corporate existences are these research divisions that a definite budget is assigned to them, and in making up the cost of *your* electric light bill or *your* telephone bill unquestionably a certain fraction is definitely assigned for further research. The reason that our telephone instruments are so superior, that our photographic films are of such a high quality, that our X-ray tubes are capable of such marvelous penetration, is due to the fact that the Eastman Kodak Company, the General Electric Company, the Westinghouse and the Western Electric Companies recognize research as an integral part of their system. The remarkable group of men that the General Electric Company has devoting their entire time to research need only be listed to show the importance of this phase, for where will you find such men as Elihu Thomson, W. R. Whitney, Coolidge, Langmuir, and, I am happy to add, a distinguished graduate of this university, Dr. E. R. Berry. What the physician owes to Coolidge for his work on the X-ray tube can not be adequately expressed Professor Thomson's and Dr. Berry's work upon fused quartz has hardly been opened. The possibilities of applying quartz to medical and optical purposes lie far beyond the original intent of the General Electric Company to secure a better insulator for high tension currents—of itself an achievement of no small distinction.

The telephone and telegraph companies would be tremendously handicapped without men like General J. J. Carty and Professor M. Pupin. The experience of many of these men reads like a novel. Those of you who have read Professor Pupin's marvelous autobiography "From Immigrant to Inventor" can trace out there the development of one of the foremost men of research in America. That Professor Pupin, working as a mathematical physicist at his desk and with pure mathematics, should have developed the theory of the Pupin coil, a theory which with a relatively few experimental proofs subsequently in the laboratory demonstrated its complete truth and made possible this simple, though effective, agent for long distance telephony, is one of the most marvelous tributes to intellectual power and research spirit. That the eminent specialist in the east can give his advice instantly and clearly in a critical case in the west is due to Professor Pupin.

Our universities have long been the fountain heads of the most of American research. Handicapped in many instances by lack of funds, overloaded with instruction and departments undermanned, nevertheless the university professor has struggled for decades and has accomplished even under these most disadvantageous conditions a vast amount of most highly productive research. Nowhere more than in the university is it clearly recognized that it is the duty of educators not simply to draw upon the fund of previously stored knowledge but to make substantial additions thereto. Indeed, a university without a sufficient spirit of research to have a definite plan of contributory activity to progress through research agencies does not deserve the name of university. Every university professor, indeed, every secondary school teacher, should have a modicum of the research spirit.

The interdependence of the university as a research center and the large industrial corporations' research laboratories is very close. Too often the glory and emphasis are laid upon the final outcome of the research. Thus one hears of the perfected motion picture, the X-ray, radio, etc., but hardly a handful of men realize that the motion picture began in the modest laboratory of the physiologist Marey in the outskirts of Paris, studying the physiology of motion, and we too often forget that Wilhelm Roentgen, who made the X-ray pictures possible, was a professor of physics in a German university, as indeed was Hertz, whose investigations form the basis for all radio work.

Obviously the man or woman intellectually well endowed, having received an excellent education, with sufficient means or environment to conduct research unhampered either by anxiety with regard to the cost of living or cost of materials and assistance, has a very great advantage over others who are less fortunate, but the research spirit remains indomitable in the research man. The spirit of research knows no handicaps. We must not forget that Pasteur carried out a long series of most critical experiments when partially paralyzed. In citing a few moments ago the names of some eminent men in connection with the General Electric Company, one name was purposely omitted, for that list contained only living men. But no one can speak of the progress of the General Electric Company without thinking of that strange, misshapen genius, Charles Proteus Steinmetz, whose every word was law and gospel in a General Electric building, a man who was suffering from many physical handicaps and deformities and yet was intellectually gigantic, a man to whom it is said no regular salary was paid. His living needs were small and modest, and the General Electric Company simply gave him "carte blanche" to draw upon them for money as he wanted it. Steinmetz worked for no material gain. He loved his work; he lived for research and he doubtless felt much of the spirit expressed by that great French chemist, Lavoisier, who not long before his tragic end by the guillotine wrote:

> To merit well of humanity and to pay tribute to one's country it is not necessary to take part in brilliant public functions that have to do with the organization and regeneration of empires. The naturalist may also perform patriotic functions in the silence of his laboratory and at his desk; he can hope through his labors to diminish the mass of ills which afflict the human race or to increase its happiness and pleasure; and should he by some new methods which he has opened up prolong the average life of men by years or even by days he can also aspire to the glorious title of benefactor of humanity.

The significance of the research spirit in teaching has been entirely, in my judgment, overlooked. There has been a feeling that research men are members of a closed corporation, that there is a sanctity of the research laboratory, a spirit of the cloistered hall of the ascetic. But this is entirely false. The teacher has the possibilities for not only instilling the spirit of research into the students but likewise of actually accomplishing research. Many of you doubtless are planning to enter teaching, that occupation of which Erasmus once said to Sapidus (a well-known German schoolmaster): "To be a schoolmaster is next to being a king. In the opinion of fools it is a humble task, but in fact it is the noblest of occupations." To-day the teacher is by no means confined to the conventional three R's, reading, writing and arithmetic. The introduction of health studies, of interest in outdoor life, observations with regard to forestry and gardening and a disposition to enter into the "raison d'être"

of things in general has entered pronouncedly into all our college curricula and our school systems.

Indeed no branch of life is devoid of research interest. If I may be pardoned a personal allusion, I have often spoken before medical and scientific societies on the importance of research, and occasionally some one has said "Yes, it is very easy for one whose life is cast in a research environment to speak about the importance of research, but what can the poor country doctor, who has no special apparatus, no large clinic, what can he do to further research?" My answer to that is this. Every country doctor has a stethoscope or at least he certainly has a hand, with which he can count pulse. I have seen an occasion where an entire research of great importance, upon the physiology of children, was absolutely stopped because this simple point was unknown. How long after a meal does the pulse rate of children, which is accelerated by the meal, return to its normal rate? It was necessary to stop one research, begin another and devote several weeks to answering this question first. Any country practitioner could have counted the pulse rate of his children after they had gone to sleep at night and have answered the question in an admirable way.

Of course there are many problems that are of interest and fewer that are of importance. The research spirit perhaps may not invariably distinguish carefully which are important and which are merely of interest, but after all it is not so much the end result as it is the encouragement and the inculcation of the research spirit throughout our entire educational life that will accomplish the greatest ends. Who knows but what before me to-day there may be sitting the future Mayo, the Elihu Thomson, the Marie Curie, the Pupin or the Carrel? With the spirit of research thoroughly imbued in our hearts, no one can dare to predict the practical results of such a spirit in the next two or three decades with the youth of to-day. Every school teacher in the most remote school has the ever-present problem of child psychology. Too little is known about it. Human behavior is almost an uncharted field. There is to-day in the air a plan for a very large research, involving the study of human behavior. Certainly the district school teacher, with a group of children ranging from 4 to 40 years, has problems of the most complex nature continually confronting her. No one needs more knowledge with regard to the psychology of youth, for every child, no matter how stubborn, no matter how seemingly indifferent, has some point of contact, which, if once found, may open up an entire new life vista. The finding of this contact, the opening up and the development of that child has potentialities of the greatest importance. To-day simple rules for psychological tests are available to every school teacher. They have of course greater or less value and one must sound a note of warning, for without intelligent interpretation of the results one can reach the conclusion which was found by one ardent investigator—that all college professors should really be classed as morons. The fact that in yonder building there is a mouse colony contributing to our knowledge of genetics and cancer is of vastly more importance to this institution as a whole, from the educational standpoint and from the spirit that it exemplifies than from the actual contributions to our fund of knowledge, great though they are.

Thus far it has been natural, perhaps too natural, for me to lay emphasis upon research from the standpoint of developing our material knowledge, and yet I feel that I can not overemphasize the *spirit* underlying research as after all being the main thing. What stimulates men and women to research? Many of our industrial organizations have adequately remunerated their scientific research men with substantial rewards that no one would think of denying them. And yet, after all, there are extremely few of the men who have devoted their lives to scientific research who have benefited financially to any great extent. One has but to think of the hundreds, if not thousands, of university professors and research workers scattered throughout this country, some of them right here on this campus, whose contributions make up the vast bulk of the scientific proceedings and communications to our various societies of learning, who are subsisting upon very small and in many cases wholly inadequate sums.

No, it is not correct to state that the urge to research is for gain. I believe it is in large part the *spirit of service*. There is inborn in every man and woman a distinct feeling to do something for some one else. This may be developed or it may be inhibited at an early age. When it is fostered and developed, it usually expands into productive service for mankind, through one of the innumerable channels. When it is inhibited, it usually fails and yet I have already pointed out to you how the true research spirit inborn in a person can overcome almost insuperable obstacles of physical and financial handicaps.

I think that all our research workers, in colleges and elsewhere, primarily are impelled by the feeling and desire to benefit the world. In other words, there is a spirit of service which is a service to both God and man. When a man dies he hopes to leave the world a little better than when he came into it. This may be through the activities of the industrialist who makes available power from unused resources, the engineer who harnesses the forces of nature, the railroad man who opens new country, the poet who unfolds new thoughts and sentiments and the beauty of life in a stimulating phraseology that reaches our listening ears, or the musician who stirs and ennobles the soul with beautiful, uplifting melody or sym-

phonic treatment of themes. Thus the research spirit is by no means confined to materialists and to material things.

It is unfortunate that the absence of the research spirit is more noticed in the phases of life other than those dealing with material developments, for it is sorrowfully true that with the tremendous material advancement of the world in the past 50 or 60 years there has not been a corresponding development of the intellectual powers with regard to the higher things of life. In spite of the decades, indeed centuries of the ever-present example of the noblest in art, there has not been a second Praxiteles. To-day we have no Rembrandts, Raphaels or Vermeers, and there is no modern Shakespeare.

We have no more "Ninth" symphonies or "Unfinished" symphonies and that tinkling tune "Yes, we have no bananas" will not make up for their loss, although the entertainment of those who enjoy that type of so-called music *may be* and unfortunately only too frequently *is* fully satisfactory. It is perhaps surprising that with our increased knowledge of resonance and the elasticity of metals and woods, there is still no substitute for the Stradivarius violin, though we have been inflicted with the saxophone. Here we have immediately a great research problem upon which we may study and reflect and should *act*, as to why is our esthetic, musical, artistic and spiritual life not more progressive? Without development there is stagnation and death, and to avoid this the entrance into our lives at every point of the spirit of research and service is essential, and this service can not be confined solely to the advancement of our material welfare, but its broader aspect must continually be kept in mind.

The recent step of your university in starting the new issue of Maine Studies, the first number of which has just come off the press and which contains a highly creditable discussion of earlier American literature, is most worthy of support from every quarter.

While the commercial returns of research are, as we have seen, oftentimes of great magnitude, the main objective for the research student must invariably be research for *the sake of knowledge*. It has long been accepted that universities must contain research centers, and students sat at the feet of Basil Gildersleeve not in the prospect of immediate rewards or riches but to draw from his fountain of knowledge. Why did students beat upon the doors of the laboratory of Louis Agassiz and why did his son, Alexander Agassiz, after the acquisition of great wealth in business enterprises, devote a large part of his life and fortune to research? The answer is "for knowledge." Certainly those of us who have enjoyed the advantages of a college education must realize that our responsibilities are consequently greatly increased, and we must see to it, for it will be through our efforts, if through any one's, that the research spirit, which is inherent in every college professor, is not too much inhibited or restricted by disadvantageous conditions. We surely can all support the research spirit and the necessity for research centers in our universities, and I firmly believe we should carry this further and emphasize the importance of the research spirit in our high schools and grammar and district schools. Bring this once effectively into play and the returns will be enormous. Obviously we can not alter the entire educational system of the state of Maine by attempting to add to an engorged curriculum or to overburdened teachers. Research above everything is not upsetting existing order. It is invariably to better the order. The old injunction "to prove all things and to hold fast that which is good" again breathes of the finest types of research spirit.

But one of the most important, if not the most important factor and result of the research spirit is its inherent tendency to develop initiative. This is of enormous educational value. In modern life there is a spirit of advance, the spirit of expectation, the spirit of hopefulness coupled with an intensity of purpose that is at times almost terrific. If this can be so directed as to develop to the fullest degree the initiative of every man, woman and child, we have the spirit of research filtering into daily life in ideal manner.

When the college graduate leaves the university halls and goes out into the world to make his way, he is immediately confronted with a situation that is strange and to which he must rapidly adjust himself. In just so far as he has been compelled to adjust himself to new environments successfully in his university career, just so successfully will he adjust himself to his new environments in his business or educational or professional career. Successful research is based wholly upon the adjustment to a new condition, a new environment. "The Occasion Instant." "Decision Difficult." Hence, personally, I have always looked with greatest favor upon all phases of academic life that necessitated such adjustments. For example, what could be more ideal for such training than the fine-grained, high principled college athlete entering into his competition clean as a hound's tooth, with the spirit to win, but with a game spirit if he loses? He adjusts himself to all possible new situations and at every period of the mile run, at every moment of the football or baseball game, the situation changes and new adjustment is necessary. Successful and rapid adjustment to this situation is the largest factor in success. If under these conditions he is fortunate enough to come out and win, no one will deny him his good fortune.

There can only be one winner, and there are lots of losers. I think that a good paraphrase of the proverb that "a good name is rather to be chosen than great riches" would be "a good loser is rather to be greeted than a vain-glorious winner." There is something fine in seeing a man take defeat in a good spirit.

We have, then, in good, clean competition, in sports, an ideal illustration of one of the fundamentals required for the best development of the research spirit, that is, the quick, successful adjustment to a new situation and environment. One of the most interesting and at the same time most important illustrations of this was developed in the late war, when the call came for doctors to go to Europe in the field. Who were the most successful doctors in the emergencies on the European battlefields? Not the great specialists of the large city, not the man whose practice was confined to office and consultations, but as a matter of fact, the country doctor showed up better than anybody else, for no one has more often to adjust himself to a new situation and an emergency than has the country doctor. The resourcefulness shown by the average country practitioner is marvelous. Could this only be directed into some research channels, the country doctor would surpass many of his hand-picked, city-bred colleagues.

Finally, we must immediately get over the idea that practical, successful research is confined to large institutions, for only too frequently does the individual amateur scientist through well-planned studies make important discoveries. The "gentleman farmer" often makes very considerable advances to our knowledge of agriculture. The importance and dignity of agriculture as a phase of economic and, indeed, cultural life, is only beginning to be felt. On the great seal of the U. S. Department of Agriculture it is stated that "agriculture is the foundation of manufacture and commerce." The great advances for the sustenance of man, his food supply, without which he can not live, the utilization of material hitherto impossible for human consumption, the scientific breeding, feeding and development of domestic animals, all are now being attacked with one of the finest organizations of research workers existent in the entire world. The United States may well be proud of its marvelous system of agricultural experiment stations, and whatever else the legislators in Washington have done, past and present, one must be thankful that they were once farsighted enough to provide large, regular appropriations such as the Hatch and Adams funds for agricultural research. Furthermore, they were wise enough to stipulate that these funds be used for research purposes only.

This idea of agricultural research had its inception years ago in Germany, where they early recognized the fundamental importance that agriculture must play in the economic life of the nation. While their agriculture had developed enormously, it could not of itself save them in their great crisis, but while their economic and sociological reverses are making heavy inroads upon their population and the health of their children, their scientific agriculture and their scientific puericulture can be but the admiration of every one who has had an opportunity to examine them.

To consider how research permeates into every field of human endeavor would be altogether too time-consuming, and we must be satisfied with accentuating the fact that without research there is no life, for to revert to the primitive man would, judged from our present standards, not be life, it would be mere existence. In every way, therefore, it is incumbent upon us as citizens of this country, as educated men and women, to give our strongest support to all educational movements which involve the development of the research spirit. In so doing not only will we have intellectual results of the most striking nature, but we have the added, if needed, incentive of the possibilities of considerable material reward and financial profit. But far above this is the inculcation of a broad and liberal spirit of progress and recognition of a necessity for adaptation to environment, to live with our neighbors, to adjust ourselves to situations as they arise from day to day, and to carry this to national existence, for we must exist with other peoples.

Even in the midst of wars we find research men ready to receive their fellow research men, even though the statesman and politician be at loggerheads. One can do no better than to quote the words of Sir Humphry Davy. In 1807 a French delegation went to London to present a medal to Sir Humphry Davy, while war between the two countries was in progress, and Davy, in receiving the medal, said: "Science knows no country. If the two countries or governments are at war, the men of science are not. That would indeed be a civil war of the worst description. We should rather through the instrumentality of men of science soften the asperities of national hostility." It was my great privilege but a few months ago to witness a similar incident, which I feel should put to shame many of us in our mental attitudes toward our former enemies. Ten months ago a great international Congress of Physiologists, including of course a large number of medical men, was assembled at Edinburgh. The committee, in preparing the invitation for this gathering, were at first in doubt as to whether the scientists of the Central Powers should be invited or not. The British Physiological Society, with characteristic British generosity, voted unanimously, as I under-

stand it, to have this invitation extended. The invitation was sent, but unfortunately, owing to the rate of exchange and the impoverishment of the nation, the Germans could not accept. One of the German professors told me it would cost him three fourths of his yearly salary to go to Edinburgh and return. In Edinburgh there was a group of public-spirited citizens who, casting aside all recollections of the horrors and sufferings of the recent war, men and women who had, I think in every instance, lost some immediate member of the family, as a result of the war, backed up this invitation to the Germans by sending a personal invitation to each German to be their house guest while in Edinburgh and furthermore a subscription was raised and three English pounds sent to each man.

Twenty-five came. I talked with many of them. I never saw a greater sense of deep appreciation exhibited by a group of men in my life. They told me they had been taken into the households of these people, had been given every courtesy, had been fed as they had not been fed in years, and I am sure that every one of these twenty-five men went back to their home land, to their classes, lecture halls and their students with warmer and deeper feelings for their former enemies than ever before, feelings that must through educational channels permeate deeply into civilian life. If these people in Edinburgh who had suffered so terribly as a result of this great conflict had breadth of human spirit enough to open their arms, take to their bosoms, into their houses, and have them break bread at their tables these representatives of their former enemies, forgetting all past offences and worshiping conjointly with these people at the shrine of that great science, physiology, how can we, thousands of miles away from the source of conflict, scarcely touched by the terrors of war, how can we, I say, consistently harbor in our hearts embittered feelings against a struggling people, struggling against a horrible self-inflicted blow. The magnanimity and humility and brotherly love exhibited at this great meeting of scientists showed me as never before that research knows no country. All are working for the best and for the advancement of mankind, and the infusion of the research spirit throughout our entire educational system can not, in my judgment, make except for a wider-visioned, better and more tolerant nation.

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WHAT IS THE LARGER MEANING OF THE VITAMINE TYPE OF ACTION?

So recent, so startling and, in a way, so bewildering are the discoveries concerning substances which, like vitamines and hormones, produce such astonishing results in proportion to the quantities involved that nobody, not even those to whom belongs the credit for making the discoveries, seems to have had time to consider very much how the substances tally with others much better known in their relation to the phenomena of living beings.

If we view the apparently certain dependence on vitaminic action of metabolism and of conception in sexual reproduction, two of the most basic of all life processes, in the light of the universally held tenet that all such processes involve the transformation of matter and energy, an extremely far-reaching question easily formulates itself: Does such dependence mean that organisms have no power to utilize physiologically the potential energies either of the substances of their own bodies or of the foreign substances ingested by them, except through the activation of these energies by substances more or less of the vitaminic type or by changes of external condition of some kind?

It certainly looks as though a conclusion of this sort is being forced upon us. But if such is the case it is hardly possible to avoid pushing the question on from the realm of physiology to that of psychology. Within the realm of psychology, or better of psychobiology, the phenomenon of stimulus and response, definitive for the whole of life, first presents itself for consideration alongside the type of action in question. And it is important to note that stimulus and response almost certainly constitute fundamentally one of those inseparable couplets, like time and space, which we are coming to see enter largely into the make-up of the universe.

Our question then forges ahead inevitably until it covers the whole range of phenomena from those connected with the reflex arc fundamental to much of animal life, to those connected with the neural, muscular and glandular systems as represented in the highest brute and human animals.

One close-at-hand possible nexus between the stimulus and response type of phenomenon and the vitamine type is furnished by the conditioned nature of the beginning of individual development from the germinal stage of all organisms that exist part of the time in this stage.

The evidence is now overwhelming that the germs of no organisms whatever are able to start by their own inherited energies on their developmental careers. Their potentialities must be activated by something external to themselves either by contacts with other bodies or by changes of condition of the surrounding bodies. The numberless researches of the modern period on fertilization point unequivocally to this conclusion. The major point of the whole matter here is more the powerlessness of latent energies to