SCIENCE

VOL. LXIV DECEMBER 24, 1926 No. 1669

CONTENTS

Medicine and the Evolution of Society: PROFESSOR JOHN C. MERRIAM 603

Research and the Universities: PRESIDENT JOSIAH H. PENNIMAN 609

Fellowship in the American Association for the Advancement of Science: DR. BURTON E. LIVINGSTON 610

William Joseph Hussey: PROFESSOR R. H. CURTISS 612

Scientific Events:
Award of Prizes by the French Academy of Science; Presentation of the Royal Society Medals to Sir Frederick G. Hopkins and Dr. D. H. Scott; Appointment of A. V. Hill to the Baker Lectureship at Cornell University; Appropriation Bill of the Department of Agriculture 614

Scientific Notes and News 617

University and Educational Notes 620

Discussion and Correspondence:
The Semi-Centenary of Willard Gibbs' Phase Law (1876–1926): ERNEST COHEN. *Second Order Stark Effect in Hydrogen:* DR. PAUL S. EPSTEIN. *Unusual Carboniferous Cephalopods:* CAREY CRONEIS. *A Parasite of the Gold-fish:* PROFESSOR T. D. A. COCKERELL. *A Contemporary of Charles Darwin:* DR. HENRY FAIRFIELD OSBORN 621

Scientific Books:
Daly's Our Mobile Earth: PROFESSOR CHARLES SCHUCHERT. *Humphreys on Rain-making and other Weather Vagaries:* PROFESSOR ALEXANDER MCADIE 624

Scientific Apparatus and Laboratory Methods:
Cement Casts of Petroglyphs: DR. HARLAN I. SMITH. *A Simple Device for Extraction and Digestion:* CHARLES F. ROGERS 626

Special Articles:
Correct Velocities for Echo Sounding in the Pacific Ocean: N. H. HECK and JERRY H. SERVICE. *The Importance of Minute Chemical Constituents of Biological Products, Nickel, Cobalt and Insulin:* PROFESSOR GABRIEL BERTRAND 627

Science News x

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.

MEDICINE AND THE EVOLUTION OF SOCIETY[1]

IN its inception medicine represented the effort to palliate or cure ills already fastened upon individuals. With advancing understanding of value in social machinery there came naturally a development of interest on the part of the community in organizing itself to guard against disease or ill health, and in some measure in protecting itself against the individual. As in practically every form of scientifically planned activity for human benefit, medicine rapidly passed beyond the stage of mere palliation, correction or warding off evils, and became a positive or constructive agency building along new lines where once it sought only to repair or to protect.

Methods and rate of advance in evolution of medicine have varied greatly. The development of a desire to carry proficiency to perfection has produced an art. A permanent cast of open-mindedness has produced research.

Achievements of the science and art of medicine which have made possible modern wonders of antiseptic surgery and of immunization are now followed by efforts aimed toward complete elimination of diseases, as in the epoch-making activity of the Rockefeller Foundation in eradication of yellow fever.

In addition to correction, cure and prevention of disease, much constructive work has been done in bringing our physical condition, at various stages in development of the individual, to a level of effectiveness not known in earlier generations. Research on the eye, coupled with utilization of lenses, gives continuing effective sight. Increase in number of deaths from troubles of the heart and of the circulatory system in general, which seem to come with higher average age, stimulated study of these organs in their relation to physiology of the whole body, with results which may give us new lease of life.

Although its effort must always be directed largely to curative and preventive functions, medicine is now in the distinctly constructive stage.

Discussion of questions touching evolution of society implies justification for the assumption that society will continue to exhibit changes of the nature

[1] Read at the public exercises of dedication for the School of Medicine and Dentistry of the University of Rochester, October 25, 1926.

which we call evolution or advance. The human problem is one of many aspects, and I am presuming to examine it, to some extent, from the point of view of one reviewing history in its longer reaches.

We may admit the almost incomprehensibly difficult nature of any study that concerns itself with the future. I am fully aware of the danger of such ventures and that the statement concerning the prophet being "not without honor, save in his own country" should, to wise men, act as a deterrent. At the same time it is clear that for guidance in many of our greatest practical problems there are no aspects of thought more clearly needing cultivation and organization at this time than just those key questions relating to the trend of human development.

To-day as never before the scientific world seems distinctly interested in the future of society. Exceptional stimulation of patriotism during the great war gave us a high expression of solidarity and effective human organization. The post-war period in scientific philosophy carried us to the other extreme, and was one in which literature was filled with reflections of certain aspects of social organization indicating incipient decline or degeneration. A decade of sustained peace has permitted products of constructive thought to accumulate. To-day, with organization of humanity reaching a stage of complexity not heretofore known, it is natural that close attention be given to examination of social movement or evolution and to search for evidence as to the direction in which it may be expected to extend.

The present status of thought concerning broader aspects of human relations is also in part due to a distinct tendency toward emphasis on fundamental philosophic concepts and toward viewing each subject in the light of its most comprehensive expression. The intensive effort expended by the specialist is seen to be of importance both because of the individual facts it furnishes for building and because the particular line of effort which it extends gives another kind of view of the whole structure of knowledge.

The expert in study of spectral lines in astronomy attains a skill of interpretation that enables him to pass instant judgment on questions concerning temperatures or movement or other conditions existing in vastly distant solar or stellar sources of the spectra. The expert on variation in mice or jimson weeds may fail to understand the distinctions separating types of spectral lines; just as the differences among mice or jimson weeds, about which he talks with such assurance, may be absolutely non-existent so far as the immediate powers of perception of the physicist or astronomer are concerned.

The significance of the situation in science of to-day is expressed in the fact that the astronomer is using the spectral line to give essential data relating to conditions indicating distance or states of motion, and other factors which concern the nature and structure of the universe. And the jimson weed expert is not so much concerned with the species or varieties of the genus Datura as he is with the principles which tell us something of the operation of reproduction, variation and evolution.

Our tendency to broader generalization and more distinctly philosophic consideration of fundamental law is itself in some measure due to a tremendous widening and deepening of the realms of space and time and movement in which our thought ranges. This expansion has tended more and more to bring about contact or overlap or connection between aspects of nature which once seemed unrelated.

In space relations, astronomy now carries its limits out so far that our solar system becomes only a speck in a vast galaxy of stars with dimensions measured in hundreds of thousands of units each representing trillions of miles. Our milky way or galaxy, with these dimensions, is seen as only a speck in a universe of galaxies of which the farthest fade out gradually to a region where they vanish, not because space ends or the world of universes terminates, but because the one telescope by which we see these remote specks has reached the limit of its power of definition.

In time relations, geology shows us the actual sweep of ages in records that hold the epochs of the past before us in order of their being. Here we see time stretched backward from our day through periods measured in hundreds of millions to billions of years—and yet the reality and meaning of that time, and of what happened in it, is like the present. Paleontology presents the moving current of life streaming through geological eons, with its marvelous history of development leading through lower forms up to man and on by stages of human progress to attainments of present culture.

As our world of scientific thought broadens and shows more and more clearly the connection between remoteness in space and time and our place in the living present, it is not possible to avoid the formulation of laws which cover also what we call the future.

With knowledge of the universe spreading at prodigious rate to cover time and space, with an acquaintance of the history of life on its march through the ages, with rapidly growing knowledge of the steps by which man has come up through gradually rising stages of physical development and culture, it is natural to inquire whether we are not now in position to make assumptions regarding the future of man and of the social organization which he forms. Can we not make such assumptions with expectation that the

attempt to look ahead will help to guide us in judgment on some of our most complicated world problems?

The term evolution of society concerns in reality both what touches the individual and the group. In recent years discussion of advance, so far as it relates to humankind, has shifted largely from consideration of the individual to investigation of evolution in the group and its products collectively.

Organic, or so-called physical continuity, is represented through the succession of individuals. Continuity in the body of knowledge and accumulated experience is represented in society. Man has advanced rapidly in building his own environment. In a sense he has created for himself a new world through accretion of contributions brought by the succession of individuals and of generations, the whole structure being held together by continuing community of interest.

In the purely social sense we are concerned with evolution or advance of methods of organization and with broad subjects, as physics, chemistry, architecture, medicine. Individuals born into this world inherit directly that which is passed on to them in their physical being and in the physical basis of their mental capacity. In the social sense they receive the accumulated benefits of knowledge obtained, organized and protected by preceding generations.

The elements upon which evolution of society depends may be discussed on the basis of many kinds of classification. We recognize advance of this group as dependent upon the common body of knowledge and experience and also upon the capacity of individuals to use these assets. Setting aside for the moment the position of the individual, we may say that advance of the group, or growth of the social heritage, is dependent upon:

(1) The securing of new knowledge by discovery, invention and research.

(2) Unification of knowledge or understanding of the interrelation of its parts; the result being an arrangement in which every item should be seen in its proper perspective or relation to every other item.

(3) Development of adequate means for establishing continuity in knowledge in what we call education of a given generation or in transmission from generation to generation. Failure to have knowledge consolidated in the community by making it common property, or failure to carry the lessons of one period to the next would mean breaking down of civilization, destruction of the advantages of the social organism, or in a large measure destruction of the new world created by man or society. It is important to recognize that education does not mean merely the handing on of information. It concerns true understanding or appreciation of the materials transmitted.

(4) Advance, development or the evolution of society is dependent upon physical and mental effectiveness of the individuals of which it is composed and upon the time available for their work.

(5) Advance of society is dependent upon continuing betterment of its economic and political organization. No matter how far we proceed in other respects, if the machinery of economic life or the methods of political organization fail to give coincidently adequate expression of individual freedom with the fruits of social cooperation, advance or evolution will be retarded.

(6) The furtherance of social development depends in a very fundamental way upon the possibility not merely of making the individual effective physically and mentally and socially, but upon the opportunity also to strengthen the type or enlarge the actual basic capacity of individuals.

The critical question toward which this paper is directed concerns the function of medicine, interpreted in the widest sense, in promoting movement or advance or betterment of the social organization which man has created. The individual in relation to the course of his life reminds one of the rider of a bicycle. He seems safe only if moving and satisfied only when advancing. Life itself is often defined as a form of motion. So society also demands the joy of change. If Wells's "Outline of History" did not convince the public on this point, the "close-up of history" in Mark Sullivan's study of "Our Own Times" will not leave possibility of doubt.

The world is hungry and thirsty for variety and also for verifiable evidences of progress. It is important to satisfy this demand without periodic resort to revolutionary methods like those of war as means of insistence upon particular modes of thought or action or as an outlet for feelings or as an exalted form of sport. Society has seemed almost regularly to turn from its treadmill round of daily duties into the fierce pleasures of making the world safe for this or that kind of economic, political or religious system. It is essential that we learn the joy of growing or evolving through appreciation and construction, instead of through mere accumulation or by the relatively easy method of destroying something.

It is my purpose to inquire whether medicine, instead of being purely palliative, curative and protective, does not make one of its most important contributions in facilitating and supporting the growth process so clearly essential to society.

As has been indicated, the advance of society is dependent upon two quite different types of evolu-

tion: one, the basic element comprised in physical and mental development of the individual; the other, the strictly social element compassed in the accumulation, organization, effective utilization and constructive development of community knowledge. Both features are essential.

One element peculiar to this problem, and to which special attention must be given, relates to the fact that human intelligence recognizes its own place in the world and insists upon expression of individuality in its possessor. The famous words, "I think, therefore I am," might well have been written, "I think, therefore I am independent." We must, of course, not forget that man sees also the importance of society to him. The individual will always assert his right to attention. In any scheme of social organization he is not only the basic element, but he demands the right to live and to grow as far as his intelligence and desires permit. Society has added the condition that this be granted so far as it is compatible with similar privilege for others.

I have already mentioned six items from the long list of elements upon which the evolution of society depends, if it is to proceed on a basis which will guarantee continuing improvement. These points were made without reference to definition of means by which the needs can be met. For our present purposes we wish to know the relation of the contribution from medicine toward meeting requirements of these points.

The *first* need concerned securing new knowledge by discovery and research through which society would better its situation. These advances must be in all possible fields, and medicine could expect at most to have only a modest part. The contribution actually made by medicine is significant, both as to actual addition of new materials and through the indirect effect upon advance of research in many other subjects.

Out of present-day organization of civilization comes the fact that the applying sciences, as in industry and medicine, have become themselves outstanding research instruments, adding much to fundamental principles of knowledge upon which they have been dependent. Such an institution as the Rockefeller Institute for Medical Research, carrying investigation into the foundations of biological and physical sciences, makes large addition to our basic knowledge.

Indirectly medicine and medical research stimulate enormous production of new information in closely related subjects, ranging from physics, chemistry and biology to economics and political administration.

Toward the *second* requirement, namely, the unification of knowledge, it is again true that the application of fundamental knowledge for specific purposes, as in medicine, leads always to the bringing together of data from many sources. The influence of organization of knowledge for the purposes of medicine makes necessary a redefinition of relationships among many other subjects which would not develop easily in other ways.

Upon the *third* point, or the need for establishing continuity of knowledge in education, it is certain that medicine, recognizing the need for knowledge of this subject by the whole people, will exert a great power to extend education so as to carry its meaning not alone through teaching of the young, but by continuing the interest and education of mature persons as well.

In development of the science of war a stage has been reached where operations on a national scale necessarily extend beyond the limits of purely military organization, and involve the interests of the whole people. Similarly in medicine, the larger program of the future can be carried out only by extending the meaning and function of medical science into the understanding and life of every individual, so that the operation becomes in large part that of society.

Many nations and civilizations that have failed might have remained had their general educational system been perfected. The time is not distant when we shall have the people as a whole informed regarding basic facts and sources of knowledge covering human health and its advantages.

Concerning the *fourth* requirement, namely, necessary betterment of physical and mental effectiveness of all individuals, this we may consider the special function of medicine above that of any other organized agency or institution in society.

The contribution of medicine toward this end results in enormous increase in effectiveness of the individual, and therefore an enlargement of the total work, both routine and constructive, accomplished by society. This means also saving of lives, increasing the number of hours' work in a given year regardless of age. It means advance of mental as well as physical effectiveness for all tasks upon which individuals are engaged. The net result is to make production greater, to increase the range or scope of living of the individual, to widen his knowledge and better his judgment. It gives a larger measure of what some have recently called "leisure." I would describe it as "opportunity to live," in the sense of opening the way for appreciation of life as we live it, and for growth within the individual life period. It is not merely with advance that individuals and society are concerned. It is the desire to obtain some advantage or joy of living from advance while it is in progress.

Lengthening life of the individual means not merely more years in which to work; it means greatly in-

creased use of cumulative individual experience. The number of persons over fifty years of age to-day, but still working hard with sound bodies, clear minds and enthusiasm of youth is greatly beyond that of earlier decades. Organized knowledge possessed by the individual is still more effectively handled than organized knowledge controlled by society. Up to the present time the mental mechanism of the individual has been more efficient and works more smoothly than the interplay of parts in society.

As medicine goes forward in development of its constructive policies it will not merely hold back what we consider preventable disease or ill health; it will go far in elimination of much that has been recognized as a part of the normal heritage of ills fastened on humanity. The individual of the future will have relatively large freedom from ills that limit other organisms. The new world which man creates will not only have the advantages of accumulated knowledge—it will have a clearer field for living and for use of knowledge than has yet been known to living beings.

I have no illusions regarding seriousness of dangers brought about by possibility of degeneration of the race through breeding from weakening stock, owing its existence to protection of society. Nor have I doubt concerning the dangers arising from crowding the world with people who have left to them little opportunity for individuality and less for development.

It is clear that certain aspects of natural selection tend to counteract some of the dangers just mentioned and that without a process of rigorous selection we must plan to meet these risks in some other way. I believe that we shall be wise enough to overcome these obstacles and to rid ourselves of the risk of breeding from weak stock. We shall some time come to recognize that deliberately bringing into life people already doomed to a heritage of suffering and of social disadvantage may be a crime comparable to that of taking life away from those already favorably situated.

The *fifth* point, relating to the necessity for contribution toward betterment of economic and political organization, is met by medicine in a larger measure than might be expected. Improved physical and mental health make for higher thought and life, thus laying foundations for bettered organization. Like the delicate adjustment of modern machinery, possibilities of social organization are limited by delicate but real distinctions, such as can be appreciated only through clear minds made possible by sound bodies. Many kinds of finely adjusted social mechanism, which might be operated by a people relatively free from physical and mental disturbances, would be impossible under conditions where widespread ill health and disease gave a different mental cast to society.

It remains also to be seen how great the influence of medicine may be in direct effect upon economic and political organization as guided by desire for health and fear of disease.

The *sixth* point, relating to dependence of social evolution upon the continuing physical and mental development of the individual, in the sense of his fundamental capacity and power, represents perhaps the most critical item of those upon which the future of society depends. It concerns the possibility of extending such a type of physical evolution as has characterized the organic world through the vast ages over which our known history of biological progress reaches, and has continued itself clearly in the history of mankind.

The problem of human betterment and advance through increasing the physical capacity and power of the individual represents one of the most important opportunities for biological science. The more narrowly limited aspects of this study have been included in the field of eugenics, which rests upon genetics in cooperation with every branch of science which concerns heredity and environment of the individual.

To open the way for a rate of advance in physical being for mankind at least comparable to that which has characterized man in his past history, eugenics must have a program which will include: (1) a full knowledge of the laws which govern heredity, (2) an understanding of any extra-individual or environmental forces which may affect the individual, (3) an understanding of the history or evolution or development of man and of other related organisms, with an interpretation of the processes which are illustrated by this course of development, and (4) an understanding of the ways by which society through its organized effort can properly influence or direct physical development of the individual in such a manner as to strengthen the type.

The study of these problems of biology applied to man represents one of the most interesting groups of investigations needed in the immediate future. It is to be assumed that through knowledge of individual and race history in other types of life we will come to understand in most respects the biological factors involved in human development. The fundamental principles of genetics will be found inextricably interwoven with basic laws of physics and chemistry. There will be many questions concerning the extent to which certain of the outstanding features in genetics of other organisms actually apply to the case of man. We shall need demonstrations sufficiently clear to bring conviction.

In the problem of development of the individual in the human group we shall meet complications not

known in study of other organisms. They will arise on the one hand out of the extreme development of our individuality, and on the other hand out of imperfectly understood influences of the community upon the individual.

There is every reason to believe that with the tremendous advance that natural science has made in understanding of the biological world, and that social science has made in interpretation of our outstanding peculiarities, we shall ultimately come to a place at which man will be able to take advantage for himself both of the laws of nature which have brought his development to the present stage and of the vast social heritage of knowledge which may be used for his future guidance. It seems impossible to believe that the introduction of intelligence into the scheme of evolution could, as some have believed, result in disasters such as are assumed to be inherent in civilization.

I believe Bryant had something of a vision when he wrote, "He who has tamed the elements, shall not live the slave of his own passions." Intelligence should make possible for a man a degree of progress at least comparable to that by which he has come to the present stage.

As, then, we review the elements which seem required if society is to proceed in its advance, it is clear that medicine in the broader sense has important relation to all the factors discussed. In certain fields its contribution is the largest made by any combination of art and science. It is the greatest factor concerned with increasing physical and mental efficiency, saving life, lengthening life and thus increasing productiveness and lifting the quality of judgment. Its direct influence in betterment of the physical stock of mankind and preparing the way for evolution is so clearly essential that without it evolution could hardly proceed.

It is not to be assumed that medicine unaided can prepare the way for continuing growth or evolution of the human group. In such a work the activity described as medicine will represent concentrated effort of many correlated fields. Chemistry, physics, biology and the anthropological and social sciences would all participate. It may be that the medicine of to-morrow will be so different from what is practiced to-day that in the language of the present it would be more readily described under designation of the sciences from which it will be composed.

The principles which will make possible the physical basis of future mental evolution of the individual and the foundations of a broader and stronger social organization will grow from application of fundamental laws or modes of procedure which biology and other sciences still find elusive and almost incomprehensible. Even the farthest advances of present research fall far short of what we need to know concerning how man may best proceed along the path of evolution. And yet it is part of my thesis that without the work of medicine in preparation of the way by bettered physical condition, improved health, increased mental efficiency, lengthening of life and pushing back of the invading hosts of disease; without embedding of scientific and medical knowledge in the minds of the people by education; without development of a more favorable physical, biological and intellectual environment in response to requirements of the new medicine;—without these contributions of medicine, it could be only through almost miraculous modification of laws guiding nature and man in the past that an intelligent society could expect to advance to greater heights. Medicine will sweep away many of the handicaps that have limited human life in the past and will also help to make more clear the laws that govern our growth.

Medicine of the future will continue refinement of its art and will develop skill comparable to that in the highest coordinated work of human hands, as in their translation of music through playing upon the instrument. Linked with the whole range of organized investigational effort, it will help to extend research to realms as remote, compared with our vision to-day, as the electron was to the scientific world of our great-grandfathers. It will bring to every worker in the field, at the same time, a better appreciation of the importance of the art of medicine and a recognition of the need for understanding as to the real limits of our knowledge.

In my boyhood I read with surpassing interest the tales of knights who devoted themselves to the not altogether unattractive business of slaying dragons and other undesirable monsters. When I came to the age at which I might enter upon adventure, the dragons had vanished. But I spent some interesting years in helping to bring life into the bones of many ancient monsters buried beneath rocks and mountains that had themselves almost succumbed to ravages of time. The actual dangers of our expeditions from rattlesnakes and bears and ticks carrying Rocky Mountain fever, and coyotes with hydrophobia were probably equal to those of dragon hunting in olden times, and I enjoyed the sport. The result of our work was, I trust, a small but real contribution to knowledge of movement of life through the ages—and of the meaning of the continuing process of creation.

And now that I have seen these visions—one, through distorted legends handed down from remote centuries, the other, a verifiable story of creation and its meaning—my interest shifts to that growing edge, where life passing through the ages determines in a measure the trend of its own future. My concern is

now with utilization of what we have to-day, trusting that, in the light of what we know from the past, it may be turned to advantage for future guidance.

I see in medicine a field of human endeavor, not only essential for well-being and enjoyment of the moment, but carrying unavoidable responsibility for that advance of mankind upon which its happiness will depend. Constructive effort in this subject will serve not only to turn the tide against the deadening influence of disease and ill health, but to exert also in some measure a creative influence. We see the forward movement of life in the remotest beginning of beginnings as we know them. To living, hoping human beings this movement can not seem naturally to terminate in any conceivable end of endings.

JOHN C. MERRIAM

CARNEGIE INSTITUTION
OF WASHINGTON

RESEARCH AND THE UNIVERSITIES[1]

IT gives me pleasure to welcome you to-day as guests of the University of Pennsylvania. As the head, for the time being, of a university, I am deeply interested in the problems of scientific research in which you have gained distinction, and in which you are still engaged. A conference called by a half dozen university presidents was held at the university last spring for the purpose of discussing research as carried on in the universities, its relation to the work of research institutes and to the great industrial corporations. There were present at the conference representatives of the universities, the research institutes, and the industrial corporations. Several important facts were emphasized by those who participated. From the point of view of the universities perhaps the most important fact is that they are almost invariably the source of training of researchers in every field of science, and the research foundations and industrial corporations look to the universities for the trained men and women to carry on the work. A second point of interest is that if research workers are to be withdrawn from universities to do the work of research institutions and of industrial corporations, it is important that universities be protected against such withdrawals of those who are in many cases their ablest teachers and investigators. The questions of immediate importance to all who are interested in scientific research are, first, how shall we train and encourage young men and young women to engage in scientific research, and how shall we afford those who are particularly qualified the opportunity to proceed without interruption along lines of study often begun with the doctor's dissertation. Is it possible for universities to set apart more or less completely from the work of teaching a number of men and women who if given the chance would probably develop into important workers in the field of science, or of any other subject included in the courses of study of our institutions of higher learning? It too often happens, as has been pointed out, that the brilliant young student is at once taken as a member of the teaching staff of his institution and loaded with teaching and administrative work to the detriment of his work in scientific investigation. I believe that practically all members of a university staff should do some teaching, not only for the development of their own minds, but also for the establishing of necessary contacts with possible future workers in their respective fields, and I believe also that many a possible research worker has his interest dulled by the routine of too much teaching. An effort that we are making at this university to solve this problem, in part at least, is based upon the idea, that a roster may be so arranged that several days in each week may be left free for the teacher to spend in his laboratory. Of course the real researcher will work in spite of unfavorable conditions, some working all night. It is not the fact that teachers do not have time to do research, but rather that their time is so broken up by teaching that it is ordinarily exceedingly difficult to obtain sufficient uninterrupted days, in which to engage in serious and continuous pieces of work. It is necessary also for universities to provide sufficient laboratory space, and a freedom from interruption, to encourage the undertaking of research work, particularly by the younger members of the faculty. In one of our scientific departments, the experiment is being made of placing all the teaching hours of the members of the faculty on certain days of the week, leaving several other days entirely free from teaching or administrative duties. This is already beginning to show results, and more results are expected as we are able to develop the system more extensively. I believe that this plan could be adopted by almost any institution, which possesses the necessary laboratory space and the necessary potential workers in the field of science. The universities are the places to which the world looks for the fundamental training of research workers, and it is important that every facility be afforded both the universities and the workers to develop human knowledge.

It is essential that research be planned and directed particularly in universities, and here we find it necessary to differentiate between the research work of the university and the research work of special in-

[1] Address of welcome to the National Academy of Sciences by the president of the University of Pennsylvania, November 8, 1926.