SCIENCE

VOL. 94 FRIDAY, AUGUST 22, 1941 NO. 2434

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.

PROBLEMS CONFRONTING MEDICAL INVESTIGATORS[1]

By Dr. WALTER B. CANNON

GEORGE HIGGINSON PROFESSOR OF PHYSIOLOGY, HARVARD MEDICAL SCHOOL

IN relation to their special concerns men of science face problems of two sorts. First, there are the enticing direct questions, presented at the outer boundaries of existing knowledge, as to what may lie just beyond. Many investigators in astronomy and biology, for example, have had their imagination stirred by such questions. To satisfy their curiosity they have striven persistently for more facts. And the facts have led to understanding of the vastness of interstellar space and the immense duration of evolutionary processes. But these facts have had an impact on society which has led to profound changes in the outlook and judgment of all thoughtful people. The revolutionary social effects of advancing science raise the secondary, more indirect questions regarding the significance of scientific progress for humanity. Such questions, also, challenge scientific workers, as they challenge other intelligent members of the body politic.

In the present essay our attention will be directed in the main to the primary professional questions awaiting medical investigation. Before they are considered, however, it may be well to note that the social effects of progress in medical knowledge appear to

[1] A contribution to a symposium on "The University and the Future of America" held at the celebration of the fiftieth anniversary of the founding of Stanford University. It will appear in a volume containing all the addresses given at the symposium, to be published by the Stanford University Press.

be of such favorable nature as to permit it to escape the harsh strictures sometimes drawn against science in general. If this is true the promotion of medicine by research should be commonly recognized as set apart in a special class, where frank encouragement should prevail rather than any aversion or hostility. Let us see what could possibly justify the unqualified support of medical investigators.

The question whether the advancement of science has not done more harm than good has been raised increasingly of late by apprehensive observers. New powers have wrought such havoc and destruction that men begin to fear the acquisition of new knowledge. Unable to check its perversion to evil purposes they propose to stop, at least for a while, further scientific progress. No one has expressed more vividly this terror of fresh discoveries in the world of nature or laid upon scientific endeavor a more sweeping curse than George Gissing. "I hate and fear 'science,'" he wrote, "because of my conviction that for long to come if not for ever, it will be the remorseless enemy of mankind. I see it destroying all simplicity and gentleness of life, all the beauty of the world; I see it restoring barbarism under a mask of civilization; I see it darkening men's minds and hardening their hearts; I see it bringing a time of vast conflicts, which will pale into insignificance 'the thousand wars of old,' and, as likely as not, will overwhelm all the laborious advances of mankind in blood-drenched chaos."

This terrific indictment, one may justly assert, does not apply to the science of medicine. By the careful studies of medical investigators devastating pestilences, which formerly spread terror through great populations, have been wholly abolished. No longer do we witness such scenes as Defoe reported in his description of the disastrous plague in London in 1665 —"people in the rage of the distemper or in the torment of their swellings, which was indeed intolerable, running out of their own government, raving and distracted and often times laying violent hands upon themselves, throwing themselves out of windows, shooting themselves, mothers murdering their own children in their lunacy." The extinction of such horrors by scientific effort should certainly mollify, if not refute, the bitter charge that science is "the remorseless enemy of mankind."

And many another beneficent triumph of medical research can be cited. Ravaging and distressing diseases, such as typhoid fever and diphtheria, have been all but wiped out. Increasing control of malaria, yellow fever and hookworm has not only lessened greatly the misery of myriads of human victims but has rendered safely habitable by man large areas of the earth where once he dwelt only at his deadly peril. Tuberculosis, long "master of the kings of death," has been dethroned; and the apathy of ignorance and despair toward it, formerly felt by both the victim of the disease and the helpless doctor who attended him, has changed to hope and cheer. Lying-in hospitals, from which at times as many as a third or a half of the mothers were carried away dead of child-bed fever, are now havens of safety and helpfulness. The conquest of surgical sepsis has enabled the surgeon to apply his skill to any part, to belly, chest or brain, in order to repair damaged structure, remove dangerous new growths or deal effectively with invasion by harmful germs. Precise studies of the ways in which the organs of the body collaborate to perform their functions have revealed the marvelous nicety of the adjustments of means to ends, and have established reliable standards for quick recognition of disorder. Aided by delicately discriminative devices—the x-rays, electrical registration of the heart beat, tests of functional capacity of various organ systems—the physician now enters the sick room with deeper insight and a more reasonable confidence of being able to learn the nature of the complaint than his predecessors could possibly have possessed.

These successes in solving the complicated problems presented by human beings in their relations to one another and to lower animals, to their shifting environment and their microscopic foes, have given medical investigators well-justified confidence in the efficacy of scientific methods. The repeated sequence of well-based ideas, and cautious experimental tests, and limited inferences, that has characterized the victorious advance of medical science, will, they firmly believe, continue to bring forth desired results—results ultimately useful in the relief of man's estate.

There is need for this confidence, because many serious problems remain to be solved. Some of them, cancer, for example, have long been impressive and insistent. Others have become more prominent as a consequence of medical research itself. Due to various conditions—and especially to improved medical care—the population of the world has doubled during the past hundred years. Vast numbers of people have gathered in immense cities where they live their stressful days in a manner sharply different from that of ancestral custom. The great cities permit concentrations of workers in huge industrial plants—*specialized* workers dependent for their daily bread on a precarious daily wage. The age structure of our population has been much altered. Formerly, the high birth rate and a continuous arrival of young immigrants made us a relatively youthful people. Since 1900, however, the birth rate in the United States has dropped more than one third, and immigration has been drastically reduced. Accompanying these changes there has been a falling death rate extending

to the sixth decade of life and therefore an increasing number of the elderly in the population. Specialization of labor, insecurity of remunerative position and an altered distribution of age groups all collaborate to present new questions for medicine to answer.

An ideal service which a university may perform for society is that of welcoming new ideas, examining them critically, evaluating them so far as possible without prejudice, and stating clearly their implications and the probable consequences of putting them to practical use. The medical department of a university should participate in these obligations. Its leaders should note the trends of social change as they may affect the demands on the medical profession, and should prepare to meet those demands with intelligence and skill. Let us consider some of the more important problems which are presenting themselves, in order that we may learn what should be done.

First, we may examine the shift of age groups already mentioned. In Sweden, where careful records have long been kept, the average length of life, late in the eighteenth century, was 34.5 years, a figure only slightly higher than that estimated for ancient Roman times; by 1840 it had increased by 7 years, and now, after decades of applied measures of public health, the increase is 28 years—from 34 to 62. Similar changes have occurred in our country. The recent speed of development of this highly significant phenomenon is illustrated in the reports of a large American life insurance company. During the quarter-century between 1912 and 1937 the life expectancy of its *industrial* policy holders advanced from 45 to 60 years—an advance of 33 per cent.—and the prospects of the general population are even better. This means that we must prepare for a future in which a larger proportion of our people than at any time in past history will reach at least threescore years in their life span. In England, between 1901 and 1937, the percentage of individuals over 60 rose from 7 and a fraction to 13, an increase of nearly 80 per cent. It is conservatively estimated that if present trends in the rates of birth and mortality continue in our country, and they bid fair to do so, by 1980 more than 14 per cent. of our population will be 65 years of age or older—approximately 22 millions instead of the 3 millions (or 4 per cent.) of forty years ago.

Besides the social, economic and industrial problems which the current increase in the number of the aged imposes there are medical problems which, though long recognized, have been long neglected. As one grows older the fires of life burn less vigorously and the adjustments of bodily organs to emergencies tend to be impaired—the breath is shorter, the heart beats less effectively, the blood pressure gradually rises as the years pass and becomes ill adapted to critical requirements. Are these features essential attributes of the elderly or are they the consequences of comfortable and habitual indolence? We know that in middle age some of these effects may result from inactivity alone and that they can be reversed by training. In the later decades, also, could they be altered by effort? Should attempts be made to alter them? What would be the effects if they were altered? These questions offer possibilities of useful research.

Then there are the characteristically different diseases in the older members of society as compared with the younger members. Chronic disorders, starting insidiously and creeping onward until they overwhelm the working ability of the victim, are not infrequent. Thus, impaired functions of the heart and kidneys, the limitations set by diabetes, the ravages of cancer, the stiffening of the arterial vessels in the brain and elsewhere accompanied by reduction of the blood supply to the tissues and by dangers of shock and paralysis—these and other persistent afflictions are likely to replace the infectious diseases encountered in earlier periods, as hazards to existence.

The mortal attacks on indispensable structures of the body—on heart, brain and kidneys—are not the only calamities of old age. These attacks do, indeed, kill. There are others, less dangerous, which sorely torment. "Rheumatism" itself and its commonly assumed guises (neuritis and lumbago, for examples), chronic inflammation of the bronchial tubes, asthma, persistent itching, which are not unusual distresses in the elderly, can render the period of senescence wearisome and miserable. Confronting such possibilities the middle-aged are naturally apprehensive as the years draw nigh when, it is said, one has no pleasure in them.

Here is a complex group of very difficult problems calling for solution. Almost none of the most prominent disorders of senescence is understood. The prevailing ignorance, we may assume, is largely due to lack of systematic study. We may reasonably expect that geriatric research, the application of scientific methods to the disorders of senescence, will reveal their nature, the conditions which induce them and the possibilities of diminishing their incidence and their injurious effects. Death, of course, must come when one or another vital organ fails its duties, but while life lasts no effort should be spared to make it a good life. Medical investigators have much to learn about how to maintain health and preserve a satisfying ability to be useful in the growing numbers of their fellows who reach the seventh decade and beyond.

In order to catch the early signs of defect reliable measures of physiological fitness are needed. Critical tests must be devised which will reveal the ability of

the organism to withstand stresses at different periods in the span of years. Criteria for judging the degree of perfection of the protective and corrective devices of our bodily economy must be established. Early infections, early injuries (both psychic and physical), early malnutrition or hygienic neglect in relation to the decrepitude of the last decades must be studied as carefully and thoroughly as possible. This will be a protracted, exacting and expensive program. University medical schools should take up the challenge and set forth in an attempt to give to the people of our country, since they are to have a longer life, the assurance that they shall have it more abundantly.

Severe demands on the nervous system, which have become progressively more severe in the recent past, have had results calling for medical attention. The conditions which have arisen may be in part the accompaniment of a remarkable shift in the occupations of our citizens. From a population 60 per cent. rural in 1900 we have become a population 60 per cent. urban. In that overturn the cities have gained from the farms more than 30 millions of inhabitants. The admirable liberty, independence and opportunity for self-direction, which typify the pursuit of agriculture, have to a large degree been exchanged for a routine of fixed hours, monotonous tasks and a sedentary existence which breaks in sharply on the ancient racial habit of using the big muscles of the body for earning one's daily bread. Furthermore, as hired hands—bookkeepers, clerks and accountants, or as operatives in foundries and factories—city dwellers become entangled in the wide-spread web of dependency. Labor strikes, business failures and revolutionary inventions involve familial tragedies of lost jobs, wrecked plans and broken homes. The intense drive and pressure of the new life, its worries and its dreads, place a burden upon men and women which often is too great to be borne. The strain is mirrored in the rise of the suicide rate of the United States during the years of excitement and depression near the beginning of the last decade. It went steadily upward until, in 1932, it was over 50 per cent. higher than during the five years after the first World War. That rise meant an increase of more than 6,000 suicides in 1932 alone.

While the stresses which affect the nervous system have been on the increase since the turn of the century, the seriousness of infections has been undergoing a remarkable decline. To this altered situation medical science has been slow in adjusting itself. The technique required for understanding nervous influences is novel and not well developed. A disorder of the brain may fail to reveal itself at the autopsy table or under the microscope. And yet emotional upsets, which leave in the nervous pathways no visible trace, have concrete and obvious effects, and may be the occasion for profound misery and suffering. Obsessive fears disturb or interrupt digestion, alarmingly accelerate the heart, send the blood pressure oscillating in hot flushes or impress a deep and stubborn sense of agitation. The poor patient, not finding sympathy and interest elsewhere, may take his troubles to faith healers or to other cultists who are attentive and who confidently promise aid. It is stupid to belittle or neglect such complaints. The powerful influence which emotional states can exert on bodily functions needs no argument. The ways in which the processes of the brain produce disturbances, however, are little comprehended; and the devices which might be employed for prevention or cure have not received the scientific attention which their importance demands. The problems which are posed are especially difficult because, in the brain more than in any other organ, man differs from the lower animals. For that reason studies on the lower forms are suggestive rather than conclusive. It will probably be necessary, therefore, that medical investigators of the neuroses, while maintaining a firm basis in physiology, shall rely on the clinic in order to find subjects for their research.

Closely associated with the mysteries of nervous instability is the most complex of all medical problems, that of mental derangement. The custodial care of the insane has immeasurably improved since St. Mary's of Bethlehem in London gave the English language the word "bedlam," and decades have passed since the wretched victims of a diseased mind were chained in outhouses and treated like wild animals. Nevertheless, in the great asylums custodial care continues to be almost the only type of treatment. And meanwhile the problem grows constantly greater and more startling. The numbers of the mentally afflicted who have been safeguarded by the State of New York rose from 390 per 100,000 in 1920 to 525 in 1938, an increase of nearly 35 per cent. in 18 years. And the appalling fact is now disclosed that as the age range lengthens, there are more and more victims of mental disease for whom protection is necessary. For example, between 1912 and 1936 the population over 40 years of age in the United States rose about 6 per cent. During that period the first admissions of patients over 40 years of age into the mental hospitals increased from about 8 to 49 per 100,000, an increase of more than 500 per cent. Half of the hospital accommodations of the country are devoted to the insane; and it is estimated that one fifth of all hospital beds are occupied by sufferers from a single mental disorder, schizophrenia. Hundreds of millions of dollars are spent every year—New York alone voted more than thirty-one millions in 1938—mainly to pro-

vide a place of refuge for the mentally diseased. Wards are extended and new buildings are erected in order to accommodate the growing numbers. Meanwhile, only relatively trifling sums are being devoted by the states to learn preventive measures by which the incidence of mental derangements may be lessened, or to discover methods which could be used to treat these derangements effectively. The outlook is not hopeless. Within the past score of years an apparently intractable disorder of the brain, general paresis, often associated with most fantastic delusions, has yielded to artificial fever and can thus be cured. Furthermore, new modes of bringing back to lives of sanity and realism persons plunged in apathetic indolence or futile day-dreams are now being tried, with a promising proportion of remarkable successes. The stupendous personal, familial, social and economic importance of the problems of psychiatry calls urgently for the labors of many well-disciplined medical investigators, devoted to research in this field.

The gradual onset of disabilities, bodily and mental, in the later years of life demands long-range studies on the possible influence of inheritance, early injuries, severe infections in childhood and youth, frustrated plans, the demands of labor and probably many other conditioning experiences. Because we each become more and more individualized as we grow older, the kind of study which is required must be correspondingly individual. Only after the collection of a vast amount of information will any reliable summary be possible.

It may be that the "general practitioner," if properly trained, would be in a more favorable position than any other type of physician to secure information useful in tracing the course of slowly developing organic disease. He would be especially well placed to obtain that information if there should be an awakening of both the public and the medical profession to the supreme value of positive, vigorous health. The advantages to be derived from securing health and physiological efficiency instead of being repaired after a breakdown needs to be emphasized. Are not hosts of our people unaware of their defects, as revealed, for example, in our young men when called to military duty? Do many of us realize that minor ills can spoil the keen edge of living? Do we strive to get into good physical condition and stay there? Do we give to our bodies, which are composed of irreplaceable parts, anything like the attention we give our machines with parts replaceable? If the human body is subjected to stress, as it is sure to be when adult responsibilities are assumed, it needs periodic examination to determine whether it is standing up well under the stress. Thus the early stage of a disorder—the stage when treatment is most effective —can be detected. If only through public education the physician might become the conservator of the family health, keeping the members well so far as possible and being instantly ready to care for them when they fall ill, an enormous benefit would be gained in the well-being of our population. And there would be established a new position for the doctor. He would become a leader in bringing about better modes of living. He would be a teacher of his people in proper diet, proper hygiene and in ways of avoiding conditions which induce disease.

In order that the functions of the physician as a personal or family "health officer" may be reliably performed, standard tests must be devised which will reveal the ability of the body to withstand disturbing influences. Normally our organs maintain a remarkably steady state, a condition of homeostasis, in the circulating blood. No dangerous variations of temperature, blood sugar or alkalinity are permitted. This stability of what has been called our "fluid matrix," in which our living parts reside, is essential for the performance of all our voluntary acts. We now know that as old age approaches, the power of maintaining that stability in the presence of deranging circumstances is gradually reduced.

As a means of obtaining further information regarding human faculties methods of assaying organic efficiency are needed. If medical investigators should invent methods for learning how human experiences affect the fundamental factors which determine homeostasis, a broad territory for medical exploration would be disclosed. The physician, for example, could learn how steady are the steady states and where the critical stress is found, not only in supposedly normal individuals, but also in individuals at various developmental epochs and during disorders. In an illuminating series of tests the abilities of the same individual could be followed in childhood and adolescence, in adulthood and old age, as affected by the demands of school or the exacting periods of puberty and the climacteric, by prolonged labor, fatigue, high altitude, different sorts of training, insomnia, worry and dissipation. Information thus obtained would furnish a measure of physiological age, a measure much more important for many judgments than chronological age. The information would also furnish, in time, a firmer basis for sound advice regarding the right conduct of one's life—the habits to be cultivated and the pitfalls to be avoided.

We now turn to another topic, the use of drugs. There was a period, not so long ago, when, with few exceptions, the possibility of affecting the course of disease by employing chemical agents was too remote to be entertained. While pathological anatomy

dominated medical thought, examination of bodily tissues after death revealed alterations in them which were so extreme that any attempt at their restoration to a natural state by drug treatment was commonly regarded as futile. So great was the lack of trust in medicaments that now that period is looked back upon as an era of "therapeutic nihilism." Advances in medical knowledge have slowly reversed the attitude of despair and have disclosed opportunities of a bright future. Diseases have gradually come to be recognized at earlier stages, when the features which are prominent are altered physiological functions. Then, before the fixed and final structural accompaniments have become established, therapeutic measures can be effective. Furthermore, hope has been revived by illustrious discoveries of specific means of curing illnesses formerly regarded as extremely dangerous or quite incurable. Antitoxin, for example, has banished the terrors of diphtheria; extracts of glands of internal secretion have, with magic potency, rescued the cretinous child from his idiocy and brought both life and vigor to wasting diabetics; preparations of liver have pushed death away from the bedside of patients succumbing to pernicious anemia; nicotinic acid has marvelously restored both the bodies and the minds of victims of pellagra; and within the last few years the miraculous cures wrought by the sulfonamide compounds have opened a door to the future that is of limitless significance.

At a time when pharmacology or pharmacotherapy faces the brightest prospects it is found to be badly neglected. In about a third of the medical schools of the United States there is no independent department devoted to the experimental study of the action of drugs and to their use in treating disease. A discipline which should enjoy a central position among the dynamic medical sciences, sending its roots into organic chemistry, physiology, biochemistry and exploratory pathology, and thrusting its outstretched branches into various hospital clinics, is often merely an incidental interest in a collateral department of the medical school.

As we have previously noted, there are many afflictions which scourge mankind concerning which almost nothing is known. Do not the triumphs already achieved give promise of further conquests? Will not trained intelligence applied to the problems of cure bring further relief to humanity in its suffering? Should not the possibilities of control of the processes of pathology be explored to the uttermost? Here, in the realm of therapy, is another gage thrown down before the investigators of medical mysteries.

A problem which confronts workers in the medical sciences and which fortunately does not disturb workers in other sciences, except psychology, is that of preserving freedom to carry on research. The amazing advances of modern physics and chemistry and their uses in arts and manufacture have developed from experimentation. Likewise the revolutionary progress in the control of disease that has been achieved during the past ninety years has resulted from practical applications of results obtained by experiments. In order to employ the experimental method, however, the physiologist, pharmacologist or immunologist must put his questions to living organisms and obtain from them his answers, for only they are capable of responding. Because medical investigators perform experiments on lower animals, however, they have been reproached and persecuted and had all manner of evil charged against them falsely. The hostile charges can be analyzed into two main groups—that animal experimentation is conducted with an intolerable infliction of pain, and that all the effort and expense are utterly useless.

It is not generally known that about a third of a century ago faculties of the medical schools of the United States established by formal vote their own humane code for the treatment of animals used in experiments and provided that this code should be posted in all laboratories where animal experimentation is extensively practiced. To any one widely acquainted with medical investigators and the methods which they employ, these regulations, when they were adopted, merely defined the already humane conditions under which experimental medicine was being conducted and stated a program for the continuance of those conditions. To beginners in research and to interested people the regulations indicated the spirit of the investigators and the consideration given by them to the avoidance of unnecessary pain. So assured were the deans of medical schools and the directors of institutes of medical research that animals are treated in the laboratories in a manner above any reasonable reproach that twenty years ago the "open door" policy was adopted. In accord with that policy there was a publicly declared willingness to admit to the laboratories at any time representatives of humane societies in order that they might become acquainted with the actual conditions under which animal experimentation is being carried on. In some instances it was stipulated that the representatives must have previously seen an operation on a human being to enable them to appreciate the similar humaneness of the laboratory methods.

The charge that the results of experiments on lower animals are useless has been amply disproved. Articles by well-known physicians, surgeons and public

health officers—all recognized experts in their several fields—have been prepared and published in the most widely circulated medical journal of the country, showing definitely how animal experimentation has contributed in a direct and decisive and fundamental fashion to practical medicine and surgery.

In spite of overwhelming evidence that animal experimentation is carried on in a humane manner, in spite of practically unanimous expert testimony that animal experimentation has been a prime factor in the beneficent advances of modern medicine, the problem of assuring freedom of research still confronts medical investigators. Persons who do not enter the laboratories in which they declare animals are cruelly tortured, who do not see the operations they criticize, who do not know about different degrees of effective anesthesia, who are unaware of the history of medical progress and of the incomparable benefits to mankind conferred by modern medical discoveries, who are indifferent to the dire problems still presented by diseases which continue to kill their thousands and tens of thousands—these persons, combining real ignorance with unchecked imagination, spread dark suspicions and insinuations about honorable men whose lives are devoted, through research, to the relief of human ills. Furthermore, these misguided humanitarians endeavor, by harrowing and misleading descriptions, to rouse the public to a degree of hostility that will result in either seriously limiting or completely abolishing the most efficacious means of advancing medical knowledge. Leaders in universities and medical schools who, during the past half-century, have fought against the foes of liberty of learning have thus far preserved that liberty—to the inestimable advantage of future generations. The fight will not cease, however, so long as there are groups of our population who would stop animal experimentation even though it releases mankind and lower animals as well from wasting disease, avoidable pain and premature death.

Struggle against the common enemies of man—disease, pain and early death—turns attention to the disastrous cooperation of these enemies with warring hosts when nations battle against nations for supremacy. The terrible devastation now going on in Europe and the fear of more extensive spread of the catastrophe have included medical research in a warping of scientific activities away from untrammeled pursuits towards problems of military significance. In our country what may be the consequences for men engaged in medical investigation? The answer to that question appears to be closely related to what may happen abroad. It seems probable that for years to come the need to repair the wreckage and the appalling waste resultant from the present titanic strife will leave European nations in such poverty that scientific studies will be sadly slighted. Whether or not the Western Hemisphere becomes involved in the conflict we are likely to find our associations with the Latin American nations south of us more and more intimate. In the past these nations have looked to Europe for medical training. Recently, however, they have begun to turn to the United States for instructive experience and discipline, both in the clinics and in the medical sciences. Circumstances indicate that this trend will continue and, as time passes, will become more prominent. The opportunity thus presented for medical investigators here to exert a stimulating influence in countries where hitherto relatively little investigative activity has been going on may have far-reaching effects. The need for development in these countries should not be criticized. We should remember that our own participation in the advancement of science has been recent. In relation to the medical sciences it may be recalled that the first experimental laboratory in our country that was available for medical research was established only 70 years ago. Before that period, what De Tocqueville wrote in 1850 was still pertinent—"that among civilized people of our age there are few in which the highest sciences have made so little progress as in the United States." We were fairly charged with collecting the treasures of the intellect without taking the trouble to create them. Although not many important centers of medical research have been established in South America De Tocqueville's charge can not properly be transferred to all that continent. The achievements of the laboratory of physiology at Buenos Aires, for example, admirably illustrate the capacity of Latin Americans to become deeply concerned with medical problems and to bring to fruition studies of first-rate importance. To some extent we have opportunity to send our promising young investigators to profit by experience with our Spanish-speaking colleagues. To a larger extent, experts in research in our university medical schools face the happy prospect of performing for enterprising candidates for careers in productive scholarship, who come from countries south, the same sort of stimulating service which European leaders in the medical sciences performed for ambitious American doctors two or three generations ago. No more effective means could be devised for strengthening the bonds of fellowship and understanding between the United States and its southern neighbors.

Finally we may note that a highly important problem which faces medical investigators is that of filling their own ranks. The young men who enter medical schools now-a-days are often well dis-

ciplined in the basic studies and therefore are prepared to enter one or other of the pre-clinical departments to engage in research. Indeed, inquiry shows that not a few medical students participate in an investigation before they receive the doctorate, and some of their published discoveries have proved important. As a rule, however, the youth who starts on the long road to a career in medicine has set as his goal his service as a practitioner. If he is enticed away from that purpose he may be made unhappy in regretting that he did not pursue his original aim. And yet, if the pressing problems of disease are to be solved, they must be solved by the devoted labors of men who single-mindedly apply their talents to such tasks. What are the rewards, the satisfactions, which a medical student may anticipate if he decides to spend his life in striving for further insight into the mysteries of the organism and the perturbations which it suffers?

First of all it is a life of adventure. William Harvey, among the foremost physiological discoverers, expressed, more than three hundred years ago, the spirit of research when he wrote:

> It were disgraceful, with this most spacious and admirable realm of nature before us, and where the reward ever exceeds the promise, did we take the reports of others upon trust, and go on coining crude problems out of these, and on them hanging knotty and captious and petty disputations. Nature is herself to be addressed; the paths she shows us are to be boldly trodden; for thus, and whilst we consult our proper senses, from inferior advancing to superior levels, shall we penetrate at length into the heart of her mystery. . . . Truly in such pursuit it is sweet not merely to toil, but even to grow weary, when the pains of discovering are amply compensated by the pleasures of discovery.

Regret has been expressed that here in our country the frontier with all its possibilities of fresh experience has disappeared. That is true in geography but not in science. All that one need do to come into direct contact with border ways and conditions is to step inside an active laboratory where experimental researches are in progress, and there, in the zone separating the known from the unknown, is a frontier which offers all the excitement and thrill of testing projected hazards. Beyond that frontier is a realm of ignorance incomparably more vast than any which the lands and waters of the earth ever enticed a man to explore. Penetration into that illimitable territory is, to be sure, difficult. It is beset by many chances of error, but, as once was true of our western border, it holds forth enticing opportunities for fruitful discoveries and it exacts rigorous qualifications of those who would venture therein.

Initiative and resourcefulness, enterprise and independence, ingenuity and skill—all are called into action. Because every discovery becomes the basis of further discovery, imaginative insight, to catch the dawning significance of a fresh revelation, is constantly stimulated. New facts suggest in turn other facts and point to unsuspected relations between phenomena which have long been known. Thus, though the investigator's interests may at the moment seem narrow and restricted, they may nevertheless lead his thought outward into unpredictable ranges of knowledge. These excursions of the imagination offer again and again suggestions for fresh adventure. The look, therefore, is always forward to what may be seen when the next step is taken. Seeking new things becomes in time a fixed habit. Past successes neither furnish contentment nor hold attention; they become fused with the established routine of existence from which it is a happiness to escape. The chance of beholding unsuspected wonders, or the demonstration that something imagined is really true, is a continuous incitement to further search, and furnishes the zest and interest which are among the greatest of the rewards.

Sometimes an investigator has the satisfaction of seeing a direct practical outcome of his studies. The question may be raised as to whether, in that respect, research in the medical sciences does not offer a considerable advantage over research in other natural sciences. Too often increased knowledge of natural forces, acquired by scientific studies, has been employed in harmful as well as in beneficial ways. To these balanced consequences, good and evil, the consequences of medical investigations, as previously noted, are in striking contrast. It would be difficult, if not impossible, to find that any one of the many important discoveries made in the medical sciences during the past hundred years has been used by fighting forces for the destruction of life or for doing harm to the enemy. Instead, medical investigators, by learning the nature and cure of malnutrition, by devising appropriate treatment for shock and hemorrhage, by discovering varieties of local and general anesthetic agents and by gaining control of infections, have immensely mitigated the torments and ravages of warfare.

There is another consideration eminently creditable to the efforts of medical investigators. Because life and health are precious and medical research is deeply concerned with protecting life and health, the triumphs of that research are put to use without regard to any national or racial difference. There is no escape from the succor which they bring. Even though the beneficiaries may despise their benefactors, they must receive the benefactions. Is a follower of the Fuehrer bleeding to death and desperately dependent on a blood transfusion? His

life is saved by methods discovered by Landsteiner, once an Austrian. Does a Japanese complain of a bewildering dizziness caused by disturbance of the internal ear? He will be in debt to Bárány, a Hungarian investigator. Does an Italian doctor wish to know whether a patient has typhoid fever? He applies observations first made by Widal, a Frenchman. Is one of our children in danger of diphtheria? His resistance to infection is tested by a process invented by Schick. Goldberger, an immigrant to New York's East Side, provided a simple preventive and treatment of pellagra, which made possible the lifting, from hosts of miserable people, the blight of that dreadful disease. And no matter in what country they may be, the tens of thousands of victims of syphilis must rest their hope of relief on a method of diagnosis first devised by Wassermann, and on a curative method discovered by Ehrlich, both Germans at a time when Germany recognized, without contempt and malignity, the value of ingenious devotion to human welfare. All these contributors to medical knowledge have been citizens of various lands, but they would all be classed as belonging to one people. And though in the last years their people have been again savagely and sadistically persecuted, no nations, however hostile, can take from these medical representatives the honor and glory of having served as saviors of their fellow men.

The attractions and the rewards of medical investigators have been described in some detail because the problem of filling the ranks of those who engage in medical research is of primary importance. Unless the ranks can be kept unbroken, unless well-equipped recruits can be attracted to the career of the investigator, progress ends. The opportunities for long-enduring service to humanity should be widely known. Gifted young men should be aware of the chances which are opened to them and should prepare themselves accordingly. Universities should remove any financial obstacles which may confront the productive scholar looking forward to decades of medical investigation. The conquest of a disease, it should be remembered, is a permanent conquest. Humanity will be protected thereby through indefinite future time. An immortality of blessed memory awaits those who bring to mankind further respite from debility and pain.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SPECIAL RESEARCH CONFERENCES ON CHEMISTRY

By Dr. F. R. MOULTON
PERMANENT SECRETARY

IN each of the past four summers special research conferences on chemistry have been held at Gibson Island, Md., under the direction of Dr. Neil E. Gordon, secretary of the Section on Chemistry of the American Association for the Advancement of Science. With the recent purchase of a property by the association for the use of the conferences they are now put on a permanent basis.

The Gibson Island conferences are unusual if not unique in character. Each conference, devoted to a single well-defined subject, occupies a period of five days from Monday to Friday, inclusive, during which ten sessions are normally held. The first session begins at 10 o'clock on Monday morning and consists of only one or two formal papers. The remainder of the time until adjournment for lunch at 12:30 is available for discussions. Usually no program is scheduled for the afternoon, but discussions by small groups often continue. A second program of one or two papers is held in the evening, followed by discussions often continuing until a very late hour. Similar schedules are followed during the remainder of the week.

The Gibson Island special conferences on chemistry owe their excellence and popularity to careful planning of the programs by experts, the choice of the invited contributors, the freedom with which contributors make excursions along, and sometimes beyond, the frontiers of the known, the opportunities for abundant discussion, the limitation of participants to sixty, the mingling of chemists from industrial and university laboratories and the delightful surroundings. At its business meeting each conference determines the subject of the corresponding conference for the following year and nominates its chairman and vice-chairman, who are formally appointed by the association.

The subjects of the conferences so far held and the names of their chairmen are as follows:

1938

A. Relation of Structure to Physiological Action. Harold C. Urey, *chairman.*