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SCIENTIFIC EXPERIMENT AND MEDICINE[1]

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MODERN medicine presents many aspects. Its fields of influence and interest have expanded into a mighty domain with the passing of the centuries. The varied and increasingly significant activities therein now awaken the concern not only of the practitioner but also of the layman. Public health and preventive medicine have become problems for the state as well as the individual citizen. A century ago the distinguished physician Laënnec asserted, with what was perhaps an exaggerated modesty, that "the aim of medicine is the cure of disease." He promptly added that this end might be attained in a multitude of ways, among which was a consideration of the nature of diseases.

The medicine of to-day is no longer satisfied with a program limited primarily to practical therapy. New enthusiasms have been developed. In discussing the changes of view-point that have been instituted in recent years, A. E. Cohn[2] remarked:

We should perhaps add, by way of interpreting or perhaps of supplementing Laënnec's meaning, that we believe it necessary as the basis of therapeutics to understand the mechanisms, that is to say, the processes which underlie the manifestations of disease, for it is these which it is one of our functions to attempt to correct. That is our practical aim. We have learned a lesson also in another direction. It is that, as in other disciplines, learning may be pursued for its own sake. And the reason for this is twofold. Men have learned that the direct is not always the shortest road to the attainment of their objects. It is true that results, ultimately of practical value, have issued from disinterested learning. But this argument still is based on utility and leaves many persons imbued with natural curiosity with-

[1] The Alpha Omega Alpha lecture, delivered at New Orleans, May, 1932.

[2] A. E. Cohn, *Jour. Clin. Investigation,* 1: 1, 1924; also "Medicine, Science and Art," University of Chicago Press, Chicago, 1931.

out enthusiasm. It is perhaps not unfair to say that these disinterested students have not been made welcome in medicine as they have been in other departments of learning. And this is a defect in our organization even if it represents no defect in our conceptions. The problems of disease offer legitimate objects of inquiry, as do problems in physiology, and may be pursued in the same spirit. The illumination which has resulted from study of this kind requires no defense. Its value in the development of science is sufficiently established [p. 128].

This spirit seems to be recognized in the functions of the Alpha Omega Alpha Medical Honor Society. Its definite mission, we are reminded, is "to encourage personal honesty and the spirit of medical research." Some of my predecessors in this lectureship have discussed present-day problems of medical ethics and programs of professional conduct before you. I sometimes wonder why it should seem desirable, if not actually necessary, to attempt to frame specific codes of ethics for the various professions; why human duty should not be reasonably clear to all educated persons and applicable with comparable convictions in all walks of human endeavor. Hence my interest in a statement in the address of the Hon. Ray Lyman Wilbur[3] at the annual meeting of the Alpha Omega Alpha in Washington, 1927. He said:

> In the profession there are a number of traditionalists to whom ritualism, etiquette and ethics are all apt to mean the same thing. There are some who have tried to hold back the advancing tides of medicine by an appeal to the principles of ethics as a method of controlling the more rapidly advancing members of the profession. They have called on the voice of the past and on authority, forgetting, as Dr. John Scotus has said, that "authority springs from reason, not reason from authority."

The "mores" of our modern society and its practice of ethics are far more likely to be motivated by human experience and the necessities of social intercourse than by the formulated dictates of groups of men.

The practicing physician, as well as the special investigator whose highest development this society ventures to promote, inevitably assumes a large burden of responsibility for the further development of medical knowledge in behalf of human welfare. The progressive devotee of medicine, notably in the earlier days, has received his inspiration from whatever opportunities were presented to him. The great chance came to our pioneer American physiologist, Dr. William Beaumont—the "backwoods physiologist," as Sir William Osler named him—in the frontier of Northern Michigan in the days when it was far away from any medical center. Beaumont quickly realized the unique opportunity that his patient, Alexis St. Martin, afforded to advance our understanding of gastric functions; and the army surgeon promptly took advantage thereof in a series of observations and experiments that are familiar to every student of medicine. To-day we marvel at Beaumont's accomplishments that were developed not in the midst of well-equipped laboratories or with the aid of brilliant mentors, but rather through his own ingenuity and persistent effort in the outposts of early American civilization. Chance observation constituted the first step in Beaumont's discoveries; and he exemplified the saying attributed to Pasteur that "in the field of observation the chance comes only to the mind that is prepared."[4]

Progress would indeed be slow in these days if it were dependent solely upon studies of the natural or accidental deviations from the routine of life. "Medicine," L. J. Henderson[5] reminds us, "has passed through the empirical, the systematic, the nosological and the morphological stages and has entered upon the experimental stage. Thus it has finally become physiological, for physiology is the larger part of experimental medicine." As F. S. Lee[6] has pointed out,

> Ancient medicine is characterized preëminently by philosophical speculation and empiricism; modern medicine by experimentation. The ancient physician was content to observe phenomena as they existed under their natural conditions, to interpret them in accordance with a philosophical system, and to treat disease in the light of what his system and past experience had taught him. The modern physician does not rely on a philosophical system. Like his forerunner, however, he, too, observes phenomena under their natural conditions; but he goes further than this and alters the conditions, and thus he obtains an alteration of the phenomena and a new standpoint from which to view them. He may apply to the cure of disease past experience, it is true, but it is past experience that has been put to the test of modern experiment. Moreover, by the aid of further experiment he pushes out into the unknown, sees disease from unusual standpoints, and devises new and hitherto unsuspected methods of dealing with it. If he forms a working hypothesis, it, too, has to be submitted to experimentation, for to-day men of medicine have little patience with a new idea that has no experimental evidence in its favor. . . . We can voluntarily control nature's phe-

[3] R. L. Wilbur, "The Honor System in Medical Practice," *Jour. Am. Med. Assn.*, 89: 569, August 20, 1927.

[4] "Dans les champs de l'observation le hasard ne favorise que les esprits préparés." These words are inscribed on the new buildings of the Cambridge Medical School, in England.

[5] L. J. Henderson, in the introduction to the translation of Claude Bernard's "Experimental Medicine," the Macmillan Company, New York, 1927.

[6] F. S. Lee, "Scientific Features of Modern Medicine," Columbia University Press, New York, 1911.

nomena in a great variety of ways; we can control their beginning, their progress, and their ending; and in this way we can make them more accessible to observation. This is the essence of experimentation. It is the voluntary control or modification of natural phenomena. It is an artificial aid to simple observation. By means of it we can penetrate more rapidly and more deeply into nature's secrets than it would ever be possible for us to go unaided.

It is often not only possible but also feasible and proper to undertake scientific experiments on man. Investigation of physiological functions in health and disease, that is, under normal and abnormal conditions, would proceed slowly at best if it were dependent solely upon studies of the human species. Many manifestations of the organism would entirely elude us if we could not create artificially the situations that bring forth the phenomena. Beaumont's observations through the gastric fistula of the volunteer patient St. Martin, for example, raised as many questions as they answered. But cases of gastric fistula were among the extreme rarities of medicine; hence endeavors were made by the Russian investigator Bassow and the French observer Blondlot, almost simultaneously, to imitate the process by art. The methods of producing gastric fistulas in animals by surgical intervention have gradually been highly perfected and have made it possible to expand greatly our knowledge of alimentary functions.

You are well aware that opposition to the use of animals for scientific purposes is voiced in some quarters. As Lee has pointed out, this opposition sometimes wilfully denies the value of animal experimentation in scientific progress; it sometimes assumes the extreme and ethically indefensible attitude of denying the right of man to use animals at all as experimental objects; and it has as its practical aim the establishment of legal restrictions against the practice. It is surely unnecessary in this presence to defend the cause of animal experimentation. The study of the history of medicine as well as your personal experiences must have developed in you the inescapable conviction that the investigation of the physical processes alike in the healthy and the diseased body—the fundament of scientific medicine—can not dispense with occasional experiments on the living animal. They are quite as essential as are admittedly the anatomical examination of the organs of the cadaver, the chemical analysis of its tissues or the physical measurements that have biological import.

Nearly half a century ago my distinguished teacher, Rudolf Heidenhain, of Breslau, offered a cogent retort to the skeptics of that period. It applies with equal or even greater force to-day. "Let us assume," Heidenhain remarked, "that the opponents of animal experimentation were given the right of censorship over all physiological publications, and that a conscientious censor would obliterate with printer's ink all the statements in a text-book of physiology that are based on facts derived from experiments on animals. Such a censored volume," he added, "would have a strange appearance: half of the text would be expunged under the blackness of the ink; while the remainder would then become for the most part unintelligible."

A recent review by Dr. Maurice C. Hall[7] of the humane work of some of our governmental agencies includes a forceful defense of the experimental method. He states:

> The world at large knows and appreciates the combat forces of the practicing physician and veterinarian. It understands that the materials for drugs are collected from far and wide and manufactured for the use of these combat forces. But it knows little of the research or the intelligence service that studies the forces of death and disease and plans new weapons. Now and then it learns from the press that a Lazear has died in a heroic proof that a certain mosquito carries the deadly yellow fever, that the field forces of the Public Health Service have lost three workers to the Rocky Mountain spotted fever with which they worked, that Francis and Lake have contracted the tularemia they were investigating, or that some courageous experimenter with radium has yielded an arm to the enemy on which he spied. For a moment a glimmer of appreciation of these soldiers of the secret service rises in the reader, but this soon dies down, and, when some fanatical opponent of this service approaches him with the tale that all such work has led to no result whatever, he carelessly puts his name to a petition that the laboratories be closed, and in so doing votes that disease and death be allowed to work their way with man and animal except as they may be fought with yesterday's weapons.
>
> Foremost of those who would close the search for knowledge and write "Finis" to the rapidly growing book of medical science is the group of men and women who call themselves antivivisectionists. About a nucleus of paid propagandists clusters this medley of kindly but poorly informed humanitarians, enemies of all medical science, sadists who conceal under an outward love of animals a cruelty towards mankind, persons who boldly flaunt the conviction that they would rather see a child die of disease than have a guinea-pig subjected to experiment to find a way to save the child, persons who admit that they would rather see a million dogs die from parasitism at nature's hands than have a hundred dogs

[7] M. C. Hall, "The Prevention of Cruelty and the Work of a Great Humane Society," *Sci. Monthly*, 34: 211, March, 1932.

subjected to studies on that parasitism by scientists to save the million dogs, and persons whose qualification for passing judgment on medical work is the qualification of an advertising man, a minister, a poet, an author or an actress. This group is the outstanding group of nature's allies in the fight between man and nature's forces of disease and death. They are the enemy aliens who would blow up our laboratories and our ammunition plants, who would cut our service of supplies to the firing line, and who would leave our fighting forces to oppose to the incessant fire of nature's forces the ancient and rusty weapons of Hippocrates and Dioscorides. They do not hesitate to declare the immeasurable services of a Pasteur things of no value; they do not hesitate to tell the medical man and veterinarian who have seen the deaths and suffering of rabies that there is no such thing as rabies; they do not hesitate to tell us who in childhood saw innumerable persons with faces scarred with smallpox pits and who now rarely or never see such faces, that vaccination is a crime. Year after year these persons hear the evidence of the benefits to mankind and to animals from experiments on animals and, year after year, with characteristic intellectual dishonesty, they reiterate the falsehood that no benefits ever came from experiments on animals. It means nothing to them that the disease and death which man deliberately inflicts on a hundred guinea-pigs or dogs to-day save the health and lives of a million persons or dogs or cows next year or in the next ten years. They cast their lot with nature's cruelties and disease and premature death on a large scale; the medical man and scientist cast their lot with man for the frustration of nature's cruelties and the prevention of disease and premature death on the large scale of nature. The antivivisectionists shut their eyes to nature's cruelties; they are not so concerned that man and animals suffer, but they are eager to lay their heavy hands on the work of scientists and to choke to death the sources of information as to how nature fights man and how man may best fight nature.

There are to-day not a few physicians as well as other friends of medicine who, although admitting the noteworthy contributions of animal experimentation, nevertheless urge that its dominant importance is passing. They refer to "laboratory work" as a current fashion, and evanescent as many fads are likely to be. Most fashions, however, leave something of permanent interest or value in their wake. Though the pendulum of enthusiasm for this or that laboratory innovation may at times swing too far, it soon reaches a stable level.

The adverse comments should, however, not be utterly disregarded; and this is specifically true of criticisms of physiological research that have recently been voiced by a distinguished British surgeon. The remarks[8] attributed to him have started a controversy that is in danger of being directed *ad hominem* rather than to the merits of the claims at issue. The surgeon complained, we are told, that "physiologists were neglecting research on man ('hominal research') and were concerned too much with research on animals; that their aloofness from medicine was increasing year by year, and that their discoveries were becoming of less use to the clinician. . . . He characterized as amusing the assumption that ready-made weapons are fashioned in the laboratory and handed over with magisterial authority to the physician, who humbly acquiesces in their prescribed use. As to surgery, he pointed out that the advances in knowledge of gastric and duodenal ulcer and cholelithiasis had been made by surgeons with little help from the laboratory. Indeed, the contribution of the laboratory to the surgery of the stomach was not only almost negligible but was potentially dangerous, because so divergent from human experience. . . . Physiology was too concerned with mice and too little concerned with men."

We may admit freely at the outset, I think, that man himself still offers a fertile field for research. Much of our investigation of man, as well as animals, has been too exclusively concerned with isolated functions; too negligent of the possible integrations of these functions as they concern the physician in his contacts with the human individual as a whole. Perhaps that is why some of the critics complain that current research is often quite futile, or at any rate that it lacks medical utility.

In an exposition of the part played by physiology in the study of disease, the late Dr. D. Noël Paton, of Glasgow, wrote:

> The object of the physiologist must be to attempt to solve all the problems of the way in which living matter acts without considering whether the knowledge may be of use to humanity. At present I fear there is a great tendency to insist that all investigations shall have a utilitarian object; but all experience has shown that most of the important advances in the application of science to medicine have been based upon investigations which primarily seemed to have no direct bearing on the well-being of mankind.[9]

When these words were written in 1919 charges of the inability of physiology to meet the needs of the clinician and of the failure on the part of the physiological teacher were being made as to-day. Paton ventured to believe that

> not infrequently the fault lies not with the physiological teacher but with the hospital physician under whom the student finds himself. The physician, after an inadequate study of the science of physiology in the remote

[8] "Criticism of Physiologic Research," Foreign Letters, *Jour. Am. Med. Assn.*, 96: 203, January 17, 1931.

[9] "Physiology and National Needs," edited by W. D. Halliburton, E. P. Dutton and Co., New York, 1919.

past, may have lost all touch and all sympathy with the science of to-day, may have sunk into an easy empiricism, and may be content to cloak his ignorance by sneers at the application of scientific methods to practice.

Lest I be accused of being an unfair protagonist because my own interests have been centered primarily in the laboratories of the biological sciences, let me turn briefly to the views of clinical investigators. How do they regard or approach the problems of the man in sickness? The objects of the American Society for Clinical Investigation are defined as "the cultivation of clinical research by the methods of the natural sciences; the unification of science and the practice of medicine; the encouragement of scientific investigation by the practitioner, and the diffusion of a scientific spirit among its members." In his presidential address before this society my colleague, Dr. Francis G. Blake,[10] insisted that clinical investigation "should not concern itself primarily with physiology, or chemistry, with physics, mathematics, or biology, nor even with the application of these subjects by the physiologist, or chemist, or physicist or biologist to the problems of clinical medicine, but primarily with the study of the phenomena of disease in all its varied aspects through intimate and constant contact with disease in the field—whether this be in the home, the office, the outpatient clinic, or the wards of the hospital should matter little, provided the contact be comprehensive enough to give a reasonably complete picture of the disease in question."

By this frank statement Blake by no means desires to imply that the so-called experimental method is either inferior or superior to the observational and descriptive procedures; his argument is merely in defense of a method of study that seems to have lost some of its popularity. Blake insists that the inductive experiment needs no defense. In the clinic, however, "its application is infinitely more difficult because the subject of experiment is man. On occasion it is possible, when the procedures employed are harmless or when willing and often courageous volunteers offer themselves as subjects for experimentation. Otherwise, the clinical investigator must have recourse to animals to test his hypotheses, must go to the laboratory and become temporarily a pathologist or bacteriologist, a chemist or physiologist. That he is increasingly able to do so is all to his credit, but when he does so let him remember that he has temporarily abdicated his position as a clinical investigator, and that if clinical investigation is to profit he must return to the more difficult problems of the clinic to test out there the hypotheses that he has in turn developed during his sojourn in the laboratory."

[10] F. G. Blake, "Clinical Investigation," SCIENCE, 74: 27, July 10, 1931.

Such a professional view-point, applied to the human patient, is by no means derogatory to traditional physiological research in the laboratory. It defines the partnership of interest that all the biological sciences have in promoting the understanding of disease. It welcomes the help that they may give, while insisting quite properly that disease involves something more. As Blake concludes: "It has become more and more apparent to the clinical investigator, a fact of course long recognized in physiology through the influence of Claude Bernard, that the search for specific causes, whether they be living organisms, chemical substances, deficiencies or what not, is but one aspect of a many-sided picture and that a real comprehension of the etiology of disease resides in an understanding of all the conditions or circumstances under which it develops. Here we are concerned with pathogenesis, not etiology in the conventional usage of the word; the study of the interplay of specific agents, environmental factors, and human susceptibilities."

The great importance of physiological researches on man is obvious; but so-called "hominal" physiology should supplement rather than supplant a method of investigation that has been so fruitful in the past and surely has not yet exhausted its possibilities of discovery in relation to the promotion of human welfare. Let us be receptive, yet somewhat wary toward the criticisms of those who exhibit a lack of sympathy or understanding toward the laboratory and its conventional procedures. In any scientific field the methods of research that are most essential can as a rule be selected best not by the layman or the theorist but by persons who have actually been engaged in its development.

Appreciation of the normal processes of life represents the starting point or the foundation of medical knowledge; without this, an adequate understanding of those deviations that represent disease can not be satisfactorily acquired. Dependence upon our instincts or on chance observations that circumstances may permit in the case of man himself can help us only in occasional instances to reach the goal of medical effort. "Quite true and obvious," we hear the critic saying; and then he asks whether, after all, there is not too much of what is called "research" of all kinds, clinical as well as laboratory; whether much of it is not quite useless and even cumbersome to the practitioner.

That person must indeed be endowed with unerring judgment who can readily distinguish between scientific value and ultimately utility in research. Who shall say what the practical aspect of a scientific undertaking or its outcome may be? I recall that the

discovery of iodine in the thyroid gland by my teacher, Eugen Baumann, was the result of a chance observation in the course of an experiment—a lucky laboratory "accident," you may say. The discovery of the x-rays by Roentgen was a by-product of another research that was likewise a chance observation. These important contributions were not the outcome of planning directed to man on the one hand or industry on the other. They were the results of the unhampered undertakings of prepared minds in the laboratory.

Many years ago I heard Sir Michael Foster remark, with apparent satisfaction, that the frog and the myograph, the dog and kymograph were no longer the alpha and omega of physiology. He was referring to the growing interest in what is now called general physiology that selects its objects for study from the lowest forms of life as well as from mammals. To-day one hears complaints that our physiological journals have become memoirs of the rat and the mouse.

Is animal experimentation really decadent? Has the laboratory actually become sterile? Is its outlook unpromising? A few haphazard glimpses into its past records may help us in evaluating its place in the scheme of medical progress. Recall, for example, the story of the thyroid: the observations of Schiff and others that it is an essential structure; the discovery of iodine and its indispensability to life; the isolation of thyroxine by Kendall; the synthesis of this therapeutically potent derivative by Harrington. It required the experimental demonstration of the function and indispensability of the parathyroid structures in animals to render safe the thyroid surgery initiated by surgeons like Kocher and Halstead. These are the records of a half century of endeavor in the laboratory, beneficent beyond measure to man, yet due primarily to the possibilities of the use of animals for research.

Again, we may point to the dramatic chapters on the discovery of pancreatic diabetes and the use of insulin in medicine. They include the pioneer surgical experiments of v. Mering and Minkowski on animals; the cogent reasoning and effective laboratory technique of Banting and Best and their coworkers; the chemical ingenuity of Abel in crystallizing insulin, the invaluable pancreatic hormone. These are not merely records of a distant past. They represent sequences of the laboratory's contributions and the beneficent part played by animal experimentation until this very year; and the end is not yet. The current conceptions of hormones—products of small organs bringing about all manner of physiological adjustments—are yearly adding to the effectiveness of therapy or furnishing clues to surgery.

Some of you may have read the interesting story recently published by W. H. Park[11] of the fight against diphtheria in New York City during the past half century. Tracheotomy was supplanted by intubation, introduced by O'Dwyer in 1884. These "hominal" methods were rarely more than palliative. The discoveries of Klebs and Loeffler relating to the diphtheria bacillus; the monumental contributions of Roux and Bering in the study of immunization and the production of diphtheria antitoxin; the chemical refinement of antitoxin; the development of toxin-antitoxin for nation-wide immunization of susceptible children—these are some of the factors that have reduced the mortality of a dreaded disease endemic in our largest city for at least 150 years, from as high as 280 per hundred thousand in 1875 to 2.8 per hundred thousand in 1930. The cases have dropped from 15,000 in a much smaller population to 3,800 in the present 7,000,000. What a tribute to the value of the laboratory and its experimental animals, without which this great advance in human well-being would have been utterly impossible!

It would be a comparatively easy task to multiply such illustrations, not in defending but rather in extolling the contributions of animal experimentation. They can be found in every department of the medical sciences. A few further examples, presented in hasty review, must suffice here. Recall, if you will, that it was a physiologist, Haldane (whose brilliant researches on normal breathing had marked him as most likely to determine what was wrong), who was sent to investigate the hideous consequences of the first mysterious war gas attack in 1915. He found that want of oxygen in the gassed victims was the prime cause of the symptoms; and effective methods of relief were consequently instituted.

The management of caisson disease and the conquest of altitude, so that a height of nearly 8 miles can be reached by the modern aviator, owe their success to the dictates of physiological research begun in the laboratory. The treatment of carbon monoxide poisoning—a growing menace of modern life—has been greatly facilitated by physiological workers, notably my colleagues Henderson and Haggard at Yale University. Through exhaustive preliminary researches on animals they have demonstrated the possibilities of formerly interdicted inhalations of carbon dioxide along with oxygen in the regulation of respiration in various untoward conditions.[12]

[11] W. H. Park, "The History of Diphtheria in New York City," *Am. Jour. Dis. Child.*, 42: 1439, December, 1931.

[12] Y. Henderson, "Applications of the Physiology of Respiration to Resuscitation from Asphyxia and Drowning and to the Prevention and Treatment of Secondary Pneumonia," *Yale Jour. Biol. and Med.*, 4: 429, March, 1932.

In a volume entitled "Scientific Research and Human Welfare," the author[13] remarks:

> In the discovery of anesthetics we have another of the many cases in which patient scientific research extending over a long period of time and calling in the services of the scientists of a number of countries has come to the aid of man to bless his life and to make his abode on earth more pleasant.

One need not revert to that eventful day, October 16, 1846, when Dr. Warren, having completed the first public demonstration of the use of ether, turned to the audience in the amphitheater of the Massachusetts General Hospital and said slowly and emphatically, "Gentlemen, this is no humbug." All of you can recall that only recently an American physiologist, Dr. Luckhardt, of Chicago, has brought forth a contribution to painless surgery in his studies of ethylene.

Physiology is beginning to explain "the true inwardness" of diseases of metabolism. It is correcting some of the mistaken notions, such as that which made uric acid a bugbear in the past. The meaning of the calorie in nutrition has become established and has brought help to the physician in so-called calorie feeding in fever as well as in the management of obesity.

From the laboratory, too, have come those guiding principles that are so useful in the difficulties presented by cases of intestinal obstruction. Loss of fluid and chloride through persistent vomiting and profuse diarrhea have been established as serious manifestations that can be successfully combatted. Anhydremia has become a reality to the clinician through the tuition of the laboratory. The demonstration of the nature of nutritional edema in feeding experiments on the lowly rat has supplied cogent indications for the better management of a unique disorder with its symptom of decreased serum proteins. The newer knowledge of the genesis of the various so-called avitaminoses is too familiar to you to deserve detailed comment. May I remind you, however, that although scurvy has been a medical problem for generations

> little progress was made in our exact knowledge of the conditions giving rise to scurvy, whether in the adult or the infant, and of the best remedies, until it became possible to investigate the question in the laboratory by experiments on animals. This important advance was made in 1907 by the Norwegian investigator Axel Holst, who found that guinea-pigs developed a disease closely resembling human scurvy when fed on a diet of grain and water.[8]

[13] F. S. Harris and N. I. Butt, "Scientific Research and Human Welfare," the Macmillan Company, New York, 1924.

The newest chapter in the story will include the isolation and possible synthesis of the antiscorbutic vitamin, vitamin C. Consider what this may mean to armies and navies and polar exploration for which scurvy was an ever-menacing problem in the past.

The etiology of gastro-intestinal ulcers is not likely to be solved at the bedside alone. Significant hints are coming from the physiological laboratories in researches like those of Ivy and others. Hematology would, I suspect, make far greater progress if its chief devotees became reconciled in larger degree to the help that animal experimentation may afford. The study of the function of the bone marrow calls for something more than a few thousand blood counts and blood smears at the bedside. Barcroft's observations of spleen function in animals have done more than years of casual observation in the human clinic to throw some light on the hitherto obscure workings of a large organ intimately connected with the blood stream.

In the February issue of *Hygeia,* Kilduffe has praised the possibilities of animal experimentation regarding the chronic leukemias. He reminded his readers how fortunate it is that birds and certain mammals are subject to a similar if not identical condition, as this renders it possible to study the disease under conditions impossible in the human being. For only through such study, he adds, can it be hoped ever to discover ways and means for the cure or prevention of these peculiar "tumors of the blood."

In these days of recurrent criticisms there is an instructive significance in the findings of the widely heralded Calmette antituberculosis vaccine trials at Luebeck, Germany. The court held, according to the cabled reports,[14] that adequate tests on animals would almost certainly have averted that regrettable catastrophe.

Lest some one may charge that surgery is far less dependent than medicine upon animal experimentation let me remind you that to-day university departments of surgery are no longer organized without facilities for animal studies. A distinguished surgeon has assured me that new operative procedures are almost always tested on animals. He reminded me that the technique of intestinal sutures, of blood vessel surgery and transfusion, the modification of intracranial pressure of which neurologic surgery makes use, the development of suitable catgut and other suture materials —each of these has been a sequence of experiments on animals. One of the greatest advances in gall bladder surgery has been the introduction of the Graham test —a direct outcome of laboratory experiments on phthaleins. Who can predict the advances that might

[14] *New York Times,* Sunday, February 7, 1932.

be made if the problems of human ulcer could be studied effectively on laboratory animals?

Why multiply illustrations? Our thesis is not a denial of the great good that can come from "hominal" physiology. The "clinical physiologist" deserves encouragement. We need more persons capable of applying physiological knowledge in the study of disease and its treatment. My plea is rather that distinguished devotees of practical medicine and surgery shall refrain from unwarranted derogatory attacks upon one of the best helps of their profession in the past. It is difficult enough to fight suffering, disease and death without being obliged to fight the ignorance and prejudices of those who would tie the arms of the laboratory worker. The ultimate objective of all methods of attack upon ignorance is the same.

In closing I can not do better than to quote from the significant words of the distinguished biochemist and Nobel laureate, Sir Frederick Gowland Hopkins, president of the Royal Society of Great Britain:

> While scientific advances of every kind tend to react upon and assist medicine it is certain that without experiments upon animals the subject can not properly advance. The necessity continually arises for performing preliminary experiments upon living animals before this or that new piece of knowledge can be applied to the relief of humanity. Much of the new knowledge can, indeed, only be won by means of such experiments. The alternatives are three: ignorance and lack of progress; experiments upon human beings; or experiments upon animals. It should not be difficult to choose among them. The emotions which have led many to reject the last alternative are among those deserving the highest respect. Such emotions, however, have too often been allowed to express themselves in combination with ignorance and with an absence of all sense of proportion. . . . The experimentalist has nothing to fear, but everything to gain, from the formation of an informed and healthy public opinion concerning his work.[15]

OBITUARY

K. K. GEDROIZ

THE staff of the Department of Soil Science of the New Jersey Agricultural Experiment Station and of the College of Agriculture of Rutgers University wish to place on record in SCIENCE their keen sorrow and regret at the death of Professor K. K. Gedroiz and, with their colleagues at other institutions and in other countries, to recognize his passing as a most serious loss to science and to agriculture. The young but rapidly growing science of the soils has lost in Professor Gedroiz an outstanding scholar whose contributions to our knowledge of the base exchange capacity and the colloidal properties of the soil have revolutionized our ideas concerning this important branch of soil science. As president of the second International Soil Science Congress that convened in Russia in 1930, he contributed materially by his great reputation toward making the congress a success, even though ill health prevented him from taking a part in its deliberations. Russia has given many great men to soil science, and the name of Gedroiz will be remembered, with those of Dokutschaiev, Sibirtzev, Kossowitch, Glinka and many others, as having laid the foundation of a new science, which is at the very base of agriculture. The director and the members of the staff of the New Jersey Agricultural Experiment Station and of the College of Agriculture of Rutgers University wish to convey to the Academy of Sciences of the Union of Socialist Soviet Republics and to their colleagues in the union and in other countries this message of sympathy and profound regret.

A. W. BLAIR
SANTE MATTSON
S. A. WAKSMAN

RECENT DEATHS

DR. WILLIAM PATTEN, professor emeritus of zoology at Dartmouth College, died on October 27. He was seventy-one years old.

RUDOLPH FREDERICK SCHUCHARDT, chief electrical engineer of the Commonwealth Edison Company, Chicago, past president of the American Institute of Electrical Engineers and a member of the administration board of the American Engineers Council, died on October 26 at the age of fifty-six years.

CURTIS CLARK HOWARD, professor of toxicology at the Ohio State University for more than forty years, died on October 23. He was seventy-eight years old.

DR. ERNST HUBER, associate professor of anatomy at the Johns Hopkins Medical School, has committed suicide. He was forty years of age.

SIR EVERARD IM THURN, explorer, anthropologist and naturalist, died on October 8, at the age of eighty years. Sir Everard was formerly curator of the British Guiana Museum and in 1919–20 president of the Royal Anthropological Institute.

ALFRED CHASTON CHAPMAN, consulting research chemist, of London, England, died on October 17 in his sixty-third year.

DR. KARL E. RITTER VON GOEBEL, professor of botany in the University of Munich, and director of the Botanical Gardens, died on October 10, at the age of seventy-seven years.

MEMORIALS

A MARBLE bust of Commodore Matthew C. Perry has been presented to the Navy Department by his

[15] "Science and the Nation," edited by A. C. Seward, Cambridge University Press, 1917.