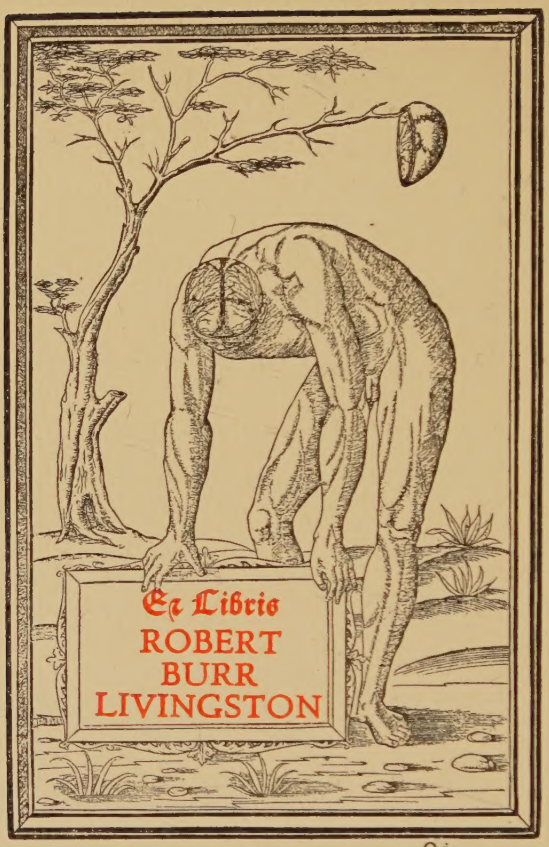
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EXERCISES

CELEBRATING TWENTY-FIVE YEARS AS
GEORGE HIGGINSON PROFESSOR OF PHYSIOLOGY
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EXERCISES IN THE AFTERNOON

OPENING REMARKS

David L. Edsall, M.D.

The mores of the people from whom we spring have become such that there is, perhaps, nothing more embarrassing and confusing to most of us than the attempt to utter our thoughts and feelings directly to a person we deeply admire and to whom we owe a great debt of affectionate gratitude for the influence he has exerted upon us. Such direct personal tributes are so unusual that the recipient often suffers even greater distress and confusion. Years after I graduated from college I said frankly to a man who had taught me there that he had influenced my choice of interests and my mental progress more than any other person. He did not answer me in words; he only looked at me. I still do not know whether that look of shocked distress meant that I had been frightfully indelicate or that he was overwhelmed with horror at what he had done.

With the conventional barriers to such intimate expressions as great as they are, it is well that when there is conspicuous reason we should, as we are doing here today, openly say in concert what is in our hearts, and lay hands upon the target of our remarks and require him to listen.

Those who achieve great things and exercise large influence are very often peculiarly modest. Their vision is so large and keen that their own part in the picture seems much smaller to them than does the

little structure built by a smaller mind seem to him who made it. The sadness in that self-painted portrait of Michelangelo in his old age seems chiefly due to the shadows cast upon his vast actual accomplishments by the far greater things that he saw in his visions but that a lifetime did not suffice for. The same is, I think, not infrequently true of great people in their advancing years. Among the most touching things I have known were the experiences of two men who had been singularly inspiring in their life work, and in their influence upon disciples, but who fell so far short of their own vision of what might be done that their lives came to seem to them gloomy failures, though happily in one case the gloom was largely dispelled by a formidable and beautiful tribute from those who had followed the paths he had opened.

The modesty that is so conspicuous an attribute of him who is the center of our meeting must, however, be of a severe and obdurate form if he can doubt the constant and multiplying evidence of the influence of his work and of the followers that he has trained.

In the academic life the value of an individual depends upon capacities of diverse kinds, some of which are less important in other forms of work. Great eminence in any one of these marks him as above most of his colleagues. Eminence in more than one brings him into a small conspicuous group. Eminence in all is most unusual. He must be a scholar to be of any moment at all, but to be a force he must be an inspiring scholar; he must, if he is to aid the

progress of his subject, be a contributor; and, in order to provide for its continuance and development, he must draw to his side able youths who will take up the torch and carry it on. The power to do each of these things is to some degree dependent upon the others. Many have some capacity in all and a good deal in one way, but really to excel in all is extraordinarily rare. That Dr. Cannon's scholarship and contributions to knowledge are very distinguished needs no comment from me in view of the very existence of this meeting and of the remarks that representatives of his field will make, and in view of the stream of distinctions that flows towards him from institutions of learning in this and other countries. Keen vision and imagination, brilliant methods of attack, and wise interpretation have brought abundant fruit, and those inspiring intellectual qualities have brought an array of disciples. I know of thirty-one persons, and there are perhaps more, who now have professorial rank in physiology or immediately related subjects and who sought their training with him. That tells its own story. They carry his influence throughout the several parts of this country, and to thousands of young students; but not that alone, for some of these men came from, and are now back in, universities in other continents. There is, further, a large company of more recent and younger men of lesser academic grade, and still others are now with him.

But there is another very important aspect of his effect upon academic personnel and progress that physiologists and others are not always so familiar

with. An imposing number of men who have come to exert a leading influence in various clinical subjects, and in the investigation done in their special fields, got impetus and vision, and the training that gave them power from him. Clinicians, however, owe more than this to him. The understanding of clinical phenomena has been made clearer and more effective in divers ways by Dr. Cannon's own work, as well as by that of those he has trained. And not only this. The pursuit of knowledge, without primary regard to its utilitarian application, is the proper and desirable aim of scientific workers; nevertheless, the ultimate value of knowledge is the betterment it brings to the physical or intellectual conditions of mankind, and those who work so close to problems of distress and suffering as do medical scientists have some degree of yearning that they may see human beings benefited in tangible and immediate ways. The definite and effective diagnosis of great numbers of cases of disease has been quite transformed by the study of the digestive tract by means of the X-ray, and the investigations of the sympathetic nervous system have already made possible great benefit, and perhaps cure, in maladies that were previously wholly discouraging, and they have surely, for both physicians and patients, brought light and hope into regions where there was only gloom before. These things are chiefly due to Dr. Cannon.

These investigations provide also a conspicuous and salutary example of the fact that research undertaken simply in the spirit of a quest for knowledge, commonly has, in the end, much larger and more

fundamental practical value than that undertaken with a hasty desire for purely utilitarian results.

The studies of the emotions have had an influence upon psychologists and psychological investigation comparable to the effect that the other studies I have mentioned have had upon knowledge of the more directly physical disorders of mankind. We may, without undue optimism, look forward to results from them, in that vastly difficult field, that will be of the greatest value in the understanding of the normal and the abnormal psychic side of human beings.

I have said that the army of followers that he has collected were drawn to him because of inspiring knowledge, imagination, and skill. That is true, but it is not the whole truth. There is an aspect of any individual, which I have not mentioned, that is not less important than any which I have stated, if one would measure the influence that he exerts. It is interesting and significant that the commonest usage of the word "character" does not now clearly include the purely intellectual qualities that I have dwelt upon, but has almost discarded them and refers to attributes of spiritual nature. In judging the worth of a person, in whatever line of activity in the world, the most decisive criterion of regard for a man or woman is contained within this common meaning of that word. The greatest achievements of the intellect may still leave their author unvenerated or condemned. In his "Robert E. Lee the Soldier," General Sir Frederick Maurice places Lee promptly among the five greatest generals in history, but in his final judgment, even though there is question

whether others were not greater as purely military intellects, Maurice advances Lee, as a soldier, beyond the others, because of the power and the selfless high purpose he showed in leading his people in the troubles that war had not dispelled but intensified. The common opinion of mankind will approve that criterion of judging his work and will welcome it as coming from a distinguished student of military strategy.

It is such qualities that must be added to intellectual powers to give the highest leadership, and I especially cite that great general because his wisdom and high-mindedness, his power to arouse trust and reliance, are an epitome of what we mean by character. It is character as represented by such qualities that, quite as much as intellect, brings loyal disciples and that lends a peculiar radiance and sweetness to this gathering and to the occasion of it.

But high character is not entirely a sober thing. The diverting side of life is both grateful and invigorating, and one of the teachings even in the nursery is of the evil effect of all work and no play. One wonders how one could play with some great people. Probably all of them could play in certain limited ways. Even so austere and stoic a seeker of the good as Marcus Aurelius could, his letters show, worry about his children's health and take them on picnics; but it is difficult to see oneself in the midst of light-hearted diversion with him. General Lee's son tells us in his biography that his father liked to have the children of his family tickle his feet, but indicates that even the family felt some distance and

austerity and that playful advances would scarcely be successfully attempted by anyone beyond childhood. The center of our interest here, however, lends both to times of diversion and to the day's work, the flavor and zest of the sport of childhood days.

Perhaps I may best epitomize him by an incident. Some years ago he repeatedly invited some ladies who were ardent antivivisectionists to visit his laboratory in order that they might see that humane methods control all its work. Finally they somewhat fearfully came, and while in conversation in his office one of them noticed a family photograph on his desk. Evidently astonished that there could be a tender side to a horrid experimenter she exclaimed, "Are those your children?" Dr. Cannon replied, "Yes, even lions make good family men." Out of the words of his own mouth shall he be confounded. It is obvious that he is an academic lion. His place in the hearts of his academic family manifests his qualities as a family man.

The physiological and the general medical world are gratefully proud of him. Those who are most grateful are those who live with him day by day.

THE INFLUENCE OF DOCTOR CANNON'S WORK UPON MEDICAL THOUGHT AND PROGRESS

Walter C. Alvarez, M.D.

It is a joy to be with you here today, and to be one of the spokesmen whom you have chosen to convey to our dear friend and honored teacher, Doctor Cannon, some idea of the kindly feelings that we all have for him on this anniversary, this mile-post in a long career of usefulness as investigator, teacher, and inspirer of youth.

I like the idea of holding birthday parties like this, and I have often wondered why we in America do not more often follow in this respect the custom of our confrères in Europe, who seem to have a better memory for anniversaries and a happier facility in expressing the feelings of homage and respect and affection that they have for their teachers. Possibly we in America have inherited from our English ancestors much of their reluctance to expose in public the inner feelings of the heart. Possibly also we see too clearly the difficulties involved in paying homage to a real man of science without at the same time embarrassing him or making him even more dissatisfied than he usually is with what he has been able to accomplish. That very clarity of vision and that absolute honesty with himself which have made possible his career of usefulness in science must always make it hard for him to see his accomplishments in the same

rosy light in which they appear to those who sit at his feet.

Tell the man of science that you think his work is fundamental and far-reaching and sound, that his reports impress you with their modesty and conservatism and clarity, and that his example and teaching are serving as stimuli to men all over the world, and you will have gone about as far as you can in making him happy. It is a human trait to be made happy by the thought that our labor is useful, and most big men are decidedly human.

It is a human trait also to depend for most of our happiness on the goodwill and approbation of our fellows. I am always saddened when I think of men like Mendel and Gibbs and Maxwell, who had to die before the world had sense enough to know what they were talking about. How wonderful it would be if we could call them back, if only for a few hours, to show them how rich has been the heritage of their ideas and how great is the honor in which their names are now held. How much better it is today when, with a world more open-minded and more eager for information, the great worth of a man like Doctor Cannon can be recognized and appreciated and honored while he is still young and keen and full of the enjoyment of life. How much better that we say now to his face what we feel about him, than that we wait until age or accident or disease has separated us and taken us one by one away.

The influence of Doctor Cannon's work on medicine. I have been asked to speak this afternoon about the influence of Doctor Cannon's work on medical

thought and progress. When I think how important an influence any teacher is likely to have, even when he never writes, but in some small school talks daily to a few students, I am appalled at the problem of estimating the influence of a man who, for twenty-five years, in one of the world's greatest universities, has not only been teaching large numbers of students, but has been publishing a steady stream of papers filled with interest and thought and new discovery, and, as if this were not enough, has been keeping in close personal contact with practitioners of medicine and their problems.

Most workers in science tend to remain isolated in a chosen field; they go to meetings only of their special societies and they leave to others the popularizing of their work and the application of it in realms of professional practice and business. But not so with Doctor Cannon; always he has been ready and willing to go before groups of physicians, gastro-enterologists, neurologists, endocrinologists, surgeons, army officers, or psychiatrists, to explain to them recent discoveries in physiology, and to help them in applying these discoveries in the working out of practical problems.

He has also served as an active member or as chairman of several important commissions appointed to investigate the causes of shock from electric burns, from hemorrhage, and from war wounds; he has joined with groups of specialists in the study of the problems of sex, pernicious anemia, and epilepsy; he has been active in the Council on Health and Public Instruction of the American Medical Association, and

he has been a tower of strength in the struggle against the antivivisectionists.

I need hardly say that his splendid roentgenologic studies of the digestive tract, made so promptly after the discovery of the new rays, had an influence on the progress of roentgenology in this country. They had perhaps an even greater influence on the development of the science and art of gastro-enterology, and for a time Doctor Cannon served as president of the American Gastro-enterological Association. He has been president also of the Association for the Study of Internal Secretions, he has joined American psychologists and psychiatrists in their researches, and he has been active on the governing boards of research foundations and hospitals.

If proof were ever needed that a university professor teaching a highly technical branch of science can be, at the same time, a most useful member of the world outside his college campus, Doctor Cannon has supplied it. He is one of these rare men of science who know how to bring scientific discoveries quickly to the notice of the "practical" man. Would that there were more college professors who could go before groups of roentgenologists, gastro-enterologists, endocrinologists, or psychiatrists, and speak so clearly, simply, entertainingly, and enthusiastically that their auditors would be thrilled with the message brought to them.

In many ways it seems a shame that a man who can do such beautiful and important work in the research laboratory must be spending time in popularizing and expounding his ideas; one wonders if other

less able men might not do this for him, and yet I think some work of this kind is well worth doing by the discoverer himself. Think how much farther along the science of genetics might be today if Mendel had taken a few months off to lecture to growers of fruit and breeders of poultry, fancy pigeons, and race horses. Even in these times it often takes twenty years or more for a new idea, just emerging from the laboratory, to be put into practice by the specialist, and unless the discovery is a startling one in the field of therapeutics, it takes another twenty years or more for it to filter down from the specialist to the general practitioner.

I feel sure, therefore, that, although under any circumstances Doctor Cannon's influence on American medicine would have been great, it has been all the greater because of his ability and willingness to enter into the councils of "practical men." His influence would have been great if he had only stood off and written for practitioners; it is greater because he has gone to their meetings and has spoken directly to them.

His influence on Medicine is great also because he has come in contact with innumerable students, most of whom are now practicing good medicine throughout this land, and many of whom are now teaching physiology and passing on to their pupils the ideals and the enthusiasm which they received in this great School.

I have already spoken of the large influence of Doctor Cannon's work on the practice of roentgen-

ology and gastro-enterology. In addition he has influenced the thoughts and practices of surgeons in regard to gastro-intestinal operations and to the care of patients who have suffered hemorrhage or shock. Most of what we physicians know today about the functions of the suprarenal medulla has come from the researches of Doctor Cannon and his associates and pupils. This work has tinged our thought and has greatly affected the progress of our study of the emotions and of fatigue.

I doubt if a scientist need ever be concerned about the immediate usefulness of what he is studying, and yet it seems to me that he should be particularly happy when, like Doctor Cannon, he is endowed with the gift for discovering facts that can immediately be put to use by men of his own generation.

Finally, one of the most important services that a man like Doctor Cannon performs for those of us who practice medicine comes about through his impressing us with the need for thinking daily in terms of physiology. Too many physicians when faced by a patient seem to have the idea that all they need to do is to find the name for the disease and then to turn to a book and prescribe the measures for relief that are to be found under the appropriate heading. Every time a great physiologist takes part in a medical symposium, more physicians are impressed with the need for thinking of disease as disturbed physiology, and of treatment as an effort to restore physiologic functions to normal. The ablest and the most constructively minded physicians today are always

thinking of their problems in terms of physiology, and all of them are indebted in some degree to Doctor Cannon.

Attributes of a man who attracts many students. On an occasion like this I cannot help stopping to wonder why it is that only a few men of eminence and outstanding ability have the faculty of gathering about them large numbers of disciples fit to carry on the torch of knowledge. What is the difference between those who leave only one or two disciples and those who, like Doctor Cannon, attract unto themselves during the course of years dozens of able young men and, after training them and exposing them to the spirit of scientific idealism, send them out into the world to become, in their turn, teachers and leaders of thought?

As I puzzled over this difference in men it seemed to me that it should be easy to foretell the qualities that must always be present in any teacher who, through his own work and that of his students, is to influence profoundly the thought of the scientific world.

First, it would seem essential that early in life the man should show that he has a gift for getting interesting things done. Surely no student with any sense is going to attach himself to a sterile laboratory.

Second, the man whom we are visualizing must be so full of enthusiasm for his work that it bubbles over and inspires those who come within its reach. As Doctor Alfred C. Redfield recently wrote me,

> Doctor Cannon's great success is due to the fact that the search for truth, and particularly physiological truth, is

akin to a religious issue which he pursues with an almost evangelical zeal. It is his faith in the importance, I might even say righteousness, of physiological investigation which seems to give him the tremendous energy which his work shows and which he manages to instill into the students who are working with him. This zeal is for the establishment of truth in general, but it is also very markedly for the establishment of physiological truth in particular.

Third, it goes without saying that the head of a great laboratory must be so full of ideas for research that he has plenty and to spare for the youngsters who come asking for problems. Moreover, and this is very important, these ideas must be practical and suited to the needs of students, many of whom have only a limited period of time at their disposal. Some will assist with the problems of their chief, but others hope quickly to learn a technic and then with its help to discover something that will be worthy of a short publication.

Fourth, the great research worker must have the knack of putting questions to Nature. He must know also which questions are likely to bring forth useful or satisfying answers, and he must be sure always that the question put is the one that was intended. I can remember the time when I got a red-headed nurse to take care of a red-headed patient so as to test the truth or falsity of an old folk idea to the effect that two rufous persons do not get on well together. Soon my two experimental animals were the best of friends; I was sure that I had established the falsity of another old saw, and then I discovered that the hair of the patient was dyed!

How easy it would be if Nature were able and will-

ing to speak up and say, "Here's a tip for you. Ask me first this and then this and this." But she is not so obliging, and much of the success of men like Doctor Cannon is due to the fact that relentlessly they keep following up clues with one well-designed question after another until, like a clever lawyer with a hostile witness, they make her come out with the truth. The reader who would like to learn something of the fascination and the difficulties of such a chase after elusive facts need only peruse the two classic articles on sympathin recently published by Doctor Cannon and his students.

Fifth, the man who is to attract many disciples must, I think, show a generous hospitality and an open-mindedness to the ideas of others. Unfortunately, we all know the type of professor who poohpoohs the research ideas of his subordinates, who more or less plainly warns them not to trespass on his chosen fields, and who soon lets them see that no young man is going to put him in the shade by publishing meritorious work from his department. Obviously, the more sterile he becomes the more sterile, perforce, must be his assistants.

I shall never forget the generosity with which, in 1913, Doctor Cannon gave me, an unknown young physician from the West with no special training in physiology, a place in his laboratory and the facilities necessary to work on the problem which I had brought with me. Soon he was taking precious time out of his busy days to look over my tracings and to advise me which leads to follow and which to leave alone; and finally, he largely rewrote my paper and

arranged for its publication. What he did for me, I feel sure, he must be doing every day for many another stranger within his gates.

An old student of Doctor Cannon's, Doctor E. L. Porter, wrote me recently as follows:

> One reason, I think, why Doctor Cannon has had such a constant stream of men collaborating with him has been his willingness, apparently, to give anybody a chance who is at all qualified. . . . You had the feeling that he warmly and enthusiastically wished you well and that you might be successful to the utmost that your abilities warranted.

Another eminent student, Doctor E. G. Martin, in summarizing his impressions of the characteristics that have contributed largely to Doctor Cannon's success as a foster-father of research workers, writes:

> I should say that they are, first, his intense devotion to physiologic research; second, his remarkable open-mindedness, a trait which has earned for him the profound admiration and respect of all who have known him well; and third, his enthusiastic interest in and spiritual and intellectual support of the research activities of his colleagues. During the ten years of my close association with Doctor Cannon I never failed to receive from him a very genuine interest in the problems on which I was working, an interest entirely free from any attempt to dominate or modify my research program. Doctor Cannon's attitude was always one of extreme modesty in discussing the research activities of his colleagues, yet when appealed to for suggestions he was always ready to take as much of his precious time as was needed to consider the problems, and would usually come through with ideas that were both stimulating and helpful.

Not only does Doctor Cannon do everything in his power to help his students when they are with him, but even after they leave he keeps up his interest in

them and their work. In this connection I quote from a letter written me by Doctor Philip Bard:

> During my first year at Princeton scarcely a week passed without a note or letter from him in which he called my attention to something he thought would interest me, or he gave me some idea which had occurred to him. That kept up during all three years and I know that others have had the same experience. . . . That is the sort of thing that goes on all the time and it is little wonder that those of us who have been fortunate enough to be his students look upon him with a mixture of affection and wonder.

Sixth, we can all be sure also that any man who for years has held the esteem and affection of dozens of youthful co-workers has been not only scrupulously fair in the apportionment of credit for work done, but actually overly generous in this regard. The order in which names should appear on the title page of a scientific contribution is often a difficult matter to decide, even when none of the workers involved have paranoid tendencies. Perhaps if Kipling had had experience in a laboratory he would have included in the poem "If" a special commendation for the man who, year in and year out, can arrange the order of precedence of authors without causing unhappiness and disappointment.

Seventh, few realize, perhaps, how much a man's ability to inspire others with thoughts of research is due to his modesty and his willingness to confess ignorance. Too many men teach in such a manner as to give their students the idea that all problems are solved and that there is nothing more to be done. I

hope that the day will come when no such person will be permitted to teach, even in a kindergarten, and surely not in a university.

In 1913, when I made my pilgrimage to see Doctor Cannon, I was full of questions which I thought he would answer. Instead, he kept saying, "I do not know," and finally, when I must have looked discouraged and disappointed, he said, "If you have some time, why not try to find the answers yourself?" How much greater was the service he did in this way than the disservice he would have done if he had sent me away with meaningless words that would have seemed to answer my questions and, in so doing, might have put an end to my curiosity.

And thus I come to the consideration of what I should have taken up first as the most important attribute of the research worker, namely curiosity. How strange it is that so many men and women are not only not curious about the phenomena about them, but actually resent the efforts of others to pry into the nature of things.

Another great attribute of all men who accomplish much is, I think, tireless energy. They must have it in order to keep driving at their work and using well every scrap of time; there must be some such explanation for the fact that they accomplish in a year more than an ordinary man does in three.

During the few months in which I worked beside Doctor Cannon I was impressed with the strenuousness of the life that he led and with the driving power which enabled him to do well not only his own work,

but that which was needed in the helping of his many assistants and students. Even his progress down the hall was often a cross between a walk and a run.

I feel sure that all of you who know Doctor Cannon will agree with me that much of his success in attracting and holding men is due to his great friendliness and kindliness and approachability. I was much impressed once by what Marcosson wrote after years spent in interviewing men who have done things in this world of ours; his thought was that one of the most striking characteristics of really great men is their approachability. They have no false front, they are frank and friendly, they soon put the caller at his ease, and give him the impression that they are really glad to see him. I need not tell those of you who know Doctor Cannon that these characteristics are all to be found in him.

Finally, I must not forget Doctor Cannon's sense of humor. As Bard says, in the afternoon when the men gather for tea and a few minute's relaxation,

> the room is kept ringing with peals of laughter incited by Dr. Cannon's witticisms and stories. It is a real factor in the spirit of the place. And in this connection let me say that this department is the most pleasant, the most free from internal discord of any department or laboratory that I have heard of. The esprit de corps is really remarkable and I think that the reason is simply Dr. Cannon's personality.

Doctor Cannon's best years are yet ahead. It is of little use to compliment the true man of science on the work that he has finished, because that no longer interests him. It was Doctor Cannon who taught me this, years ago. As he said then, "Some day you will

learn that work that is done and published gives little satisfaction; it is behind you, you have lost interest in it, and all you can think about with pleasure is the work in hand, and that which you have planned ahead."

Actually, as someone has somewhere pointed out, a tendency to glory in past achievement is a sure sign of decadence and mental death, while a forward look is a sign of youth. This being so, we can rejoice the more at the signs of youth in this man who during the last ten years has done even more stimulating work than he ever did before, and who now, with new and better facilities at hand, is eagerly looking into the future.

We all know Osler's statement that few great discoveries are made by men over forty-five, and, granting that there is much truth in this, I think we tend to assume that the trouble is a failure of vision, a drying up of ideas, and perhaps a loss of open-mindedness. The more I see of humanity the more convinced I am that there are at least three mental types: first is the mental standpatter, the ritualist, and the worshipper of textbooks; he is born that way, or at any rate his mental windows are locked shut long before he leaves college. Second, there is the man who has capabilities for doing research but not the passion for it that will cause him cheerfully to take vows of poverty and to follow the gleam all his life. He soon finds his way into more lucrative walks of life, and the world of science knows him no more. Finally, there is the man whose passion for research is so great that it dominates his behavior throughout life. His

mind was open to begin with and his curiosity insatiable. Why shouldn't he, then, like our honored teacher here today, be doing better work in his fifties than he did in his twenties?

My impression is that when these few highly gifted men begin to fail in their scientific productiveness the cause is to be found in the strangling and enervating effect of the ever-increasing burden of administrative and educational and social work which is piled on their shoulders. They are dragged away from the laboratory to attend endless committee meetings; they have to spend endless hours helping students and assistants; they have to be nice to rambling celebrity hunters and admirers coming from the ends of the earth, and they even have to spend time listening to praise of themselves at meetings like this!

The result of all this is that much of the research that a man does as he grows older must be done by proxy, or in other words, by assistants. This is all right in that more work can be done with the help of more hands, but the trouble is that unless the assistants are highly gifted the "breaks," or those invaluable side-alleys that open up during the progress of every piece of research, are likely to be missed. As someone has said, research consists largely in having a gifted observer around at the moment when Nature is doing something. Unless assistants possess the divine spark they will see only what they are told to look for and nothing else.

I think one great secret of Doctor Cannon's success in research is that with all he has had to do he has

literally "kept his hand in." The last time I visited him in his laboratory I found him in the operating room, actively using that wonderful technical skill which is his. So long as he can continue to do this, so long as a wise president and wise dean and devoted assistants combine to spare him from tasks which others can do, I look to see him carrying on, ever bettering the brilliant work of the past.

THE DEVELOPMENT OF PHYSIOLOGY DURING THE PAST TWENTY-FIVE YEARS AND DR. CANNON'S INFLUENCE UPON IT

William H. Howell, M.D.

I count it both an honor and a pleasure to have this opportunity of paying a tribute to a colleague so universally respected and admired as Dr. Cannon. Although somewhat his elder, we belong substantially to the same generation, the second generation of American physiologists, and we have long been companions in arms in the service of our beloved science. When we entered upon the scene, physiology in this country had passed its pioneer stage. The work of Bowditch and Martin and Chittenden had established the subject upon a firm footing in our universities, and we of the succeeding generation found ourselves charged simply with the duty of carrying on the work in the same spirit in which it had been begun. Following in the footsteps of Bowditch, Dr. Cannon has developed here a department of physiology whose reputation is world-wide and whose brilliant contributions are a credit and an ornament to American medical science.

I do not propose to discuss in detail the numerous publications that he has made in the subject. It is a long and honorable list, consisting almost entirely of the results obtained from well planned and skillfully executed laboratory researches. But I may refer

briefly to what seem to me to be his major contributions, based in each case not upon a single set of experiments but upon a maintained systematic series of investigations.

He made his début in physiology through a series of publications upon the movements of the alimentary canal during digestion, using the then novel method of X-ray examination. It is not too much to say that these studies illuminated the subject as no work before had done. Physiologists had long been aware of the fact that the transportation of food through the different sections of the alimentary tract is not effected solely by a simple propulsive activity of the muscular tube. There was evidence of a certain orderliness in these movements, a selective, and, as it were, purposeful discrimination at various points which gave to the process the characteristics of a teleological mechanism, but in the nature of the case it was not possible to study them, or, at least, to observe them directly under normal conditions. Cannon's method enabled him to overcome this difficulty. He could follow in detail the sequence and character of the movements under various conditions. The description that he was able to give, especially of the intestinal movements, has become a classic in physiology. This work served to demonstrate in an impressive way the highly adaptive character of the movements of the stomach and intestines in handling their contents and preparing them for adequate digestion and absorption. Its value was recognized at once by the physiologists, but because of its fundamental and positive character it proved to be of im-

mediate service also to the surgeon and the gastroenterologist. They were quick to appreciate its merits and to utilize it in a practical way.

It is characteristic of much of Cannon's work that it has not only thrown light upon some of the intricate mechanisms of the body with which the physiologist is primarily concerned, but it has had also a useful application to theory and practice in other branches of biological science. Just as his work upon the movements of the stomach and intestines found an important application in medical and surgical practice, so his long continued studies of the conditions of activity of the endocrine glands have provided the psychologists with an objective reaction of emotional states which they have accepted with eagerness as a real contribution to a most difficult subject, one that heretofore has been susceptible to approach mainly through the uncertain method of introspective analysis.

This series of experiments has included not only a study of the conditions of activity of the adrenal and thyroid glands, but has involved necessarily a consideration of the control of the secretions through the sympathetic nervous system, and it is the information they have brought us in regard to the physiological significance of this diffuse appendage to the central nervous system that I would reckon as Cannon's most important contribution. It is a contribution, in fact, which we must recognize as one of the really fundamental additions made to the subject of animal physiology in our generation. Our modern conceptions of the sympathetic system are based upon the

anatomical and physiological investigations of Langley and Gaskell. They gave us a true picture of its internal structure and connections, and the peripheral distribution and activity of its constituent fibers. But this information has been greatly extended and supplemented by the beautiful researches of Cannon and his co-workers.

He conceives of the sympathetic system as not essential for the bare maintenance of life under uniform or protected conditions, but as fulfilling the functions of an emergency mechanism which comes into play under the strain of marked environmental changes, such as exposure to cold, hypoglycemia, asphyxia, muscular effort and, especially, strong emotional excitement. Under these conditions the system is reflexly affected as a whole with the results of an increased secretion of adrenalin, a mobilization of sugar in the circulation, a more rapid heart beat, a change in the distribution of blood, an increase in the circulating red corpuscles and a deeper ventilation of the lungs, all of them reactions that tend to put the animal into a more favorable condition to protect itself from environmental stresses. The regulation is an inborn one. The sympathetic, like other parts of the nervous system, with the exception of the cerebral cortex, does not depend upon the educational influence of repeated experiences. It is an apparatus provided at birth by inheritance to safeguard the integrity of the organism.

While there may be some question as to whether this view expresses all that may be said regarding the functional value of the sympathetic system, there can

be no question that it gives us one most important phase of its activity. Especial interest attaches to its connection with psychical states. Whatever may be the neural changes underlying emotional activity, and wherever they may express themselves in the cerebral mechanism, it seems to be clear that they affect subcortical centers connected with the sympathetic outflow and thereby adapt the animal in automatic fashion to meet hostile or harmful influences in its environment. While our volitional and intellectual reactions express themselves on the motor side through the cerebro-spinal pathway, the affective phases of our mental life find an efferent outlet through the autonomic system and bring into play the regulatory activity of the hormones of the glands of internal secretion. Cannon has demonstrated this relationship with admirable completeness for the chromaphil system of the body. His work has thrown a flood of light upon the physiology of the sympathetic nervous system and has given to the psychologist and philosopher an objective reaction of fundamental importance to the understanding of that primitive phase of psychical life which we designate under the general term of feelings or emotions.

There is still another contribution of general importance to which I would like to make a brief reference. During the Great War, in connection with Dr. Cannon's services in the medical corps of the army, the opportunity, indeed the necessity, came to him to apply his experimental skill to the study of one of the serious practical problems of human surgery. As a member of the special group formed by the

British Research Committee for the investigation of so-called surgical shock he contributed a masterly series of experimental studies which are of permanent value.

Shock has long been a subject of inquiry by both physiologists and surgeons, but, while the final symptoms are easily determined, the causal factors that initiate the condition have been difficult to discover. Owing to its pressing importance during the war, committees were organized in both the American and British service to undertake a comprehensive investigation of the nature and cause and treatment of shock. Of all the work done at that time it seems to me that the results obtained by Cannon give us the clearest and most probable explanation of the vicious series of changes which lead eventually to the depression of the circulation and its attendant symptoms. The essential point that he brought out is the fact that blood is lost from the circulation, although not from the body, by being drained into the dilated capillary region, a condition for which he proposed the expressive term, exemia. It is this exemic state that induces shock, and remedial treatment must be directed toward its prevention or removal. Perhaps we shall never be wholly successful in this regard until we understand better the physiology of the capillaries.

During the quarter of a century or more that Dr. Cannon has been an active worker he has become one of the acknowledged leaders of physiology in America. He owes this position primarily to the number and quality of his own researches, but in addition he has been the master and exemplar for a large group of

pupils whose work has widened his influence and brought distinction and credit to American physiology. Moreover, as a wise counsellor he has contributed in many indirect ways to the advancement of science and particularly to the rapprochement between physiology and clinical medicine.

In looking back over this era in the history of physiology one may inquire what have been its special characteristics. Has it been in any sense epoch making? Has there been any fundamental change in viewpoint, any marked break in the trend of development that was in process at the end of the last century? On the material side certainly there has been amazing progress, so marked and rapid that in the history of the subject in this country it may well be set aside as a distinctive period. The American Physiological Society has blossomed from a small local group of workers into a great organization spreading over the entire country. There has been a multiplication of fine laboratories, splendidly equipped and generously supported. Our special journals have increased rapidly in number, and the volume of original work is such that few, if any, individual students can keep fully abreast of the advancing wave of new knowledge. To meet this need we now find it necessary to resort to the device of review journals to keep us informed of what is going on in fields other than our own.

On this side there is no occasion for complaints or criticism. The development has exceeded anything that might have been reasonably anticipated twenty-five years ago — nor do I think that any just criti-

cism can be made in regard to the quality of the work that has been done in this country. With our abundant facilities we might possibly be contributing something more in the field of pure science, but that is a matter which time will mend. We may hope that the third or fourth generation of workers will produce some of the world-leaders in the subject. We have, at least, won our independence of European tutelage and can develop in accordance with our own genius and special conditions.

As regards the kind of work that has been going on during this period there has been no revolutionary change. The underlying spirit and aims and methods of our investigations are identical with those which inspired our predecessors. There has been progress in plenty, but it has followed, so to speak, a smooth curve which took its start at the beginning of the nineteenth century. In spite of much good work and many names eminent in science the eighteenth century managed to get itself in the end upon a wrong path. The laborious procedures of experimentation were subordinated to the seductive methods of speculation and deductive reasoning from great general principles. Comprehensive generalizations, such as the Brunonian system in medicine, or the fascinations of the "Naturphilosophie" captivated men's imaginations and led to endless discussions, but the yield in positive additions to our knowledge of living nature was disappointingly small.

Toward the end of that century and at the beginning of the nineteenth century a group of very distinguished and able men in France — Cuvier, La Place,

Lavoisier, and their eminent colleagues in the Académie des Sciences—succeeded, by the force of example and the unanswerable logic of results, in bringing science back again to exact methods of research based upon experiment and observation. In physiology at that time Magendie was an uncompromising defender and advocate of the experimental method of inquiry, and his example and especially his writings had a widespread influence on young workers in the subject. But it was in Germany that the reform was actually effected so far as physiology is concerned. The four or five decades following 1830 were the golden age for physiology.

It was just about one hundred years ago that Johannes Müller was appointed to the Chair of Physiology at Berlin. Although brought up himself under the influence of Schelling's philosophy, and throughout his life a supporter of vitalism, his pupils, Du Bois Reymond, Helmholtz, Brücke, Schwann, with Liebig, Ludwig and others, made physiology over as an experimental science and gave to it the principles and aims which have governed its development ever since. It is astonishing how rapidly the science grew under this new impulse. Under the banner of mechanism the methods of physics and chemistry were applied in every possible way to discover the properties of living matter. Physiology, said Claude Bernard, is definitely launched upon the experimental path and has only to pursue its course. We have lived and worked under the influence of this spirit.

It is true that not a few distinguished physiologists, then and now, have declared their belief in some form

of vitalism. They have felt that the essential purposefulness, the extraordinary adaptability of the living organism to its environment, and the psychical attributes manifested, at least in the higher forms, imply something of the nature of a guiding influence or idea or entelechy which is peculiar to living things. But whatever may have been the philosophical beliefs of these workers, their methods of research have been experimental.

Physiology during this century has been very consistent in its devotion to this method and by virtue of this fact has been conspicuous among the biological sciences for its freedom from speculative tendencies. The older group of the previous generation were more philosophically inclined. They were much concerned with some of the ultimate problems, particularly the phenomenon of consciousness. They counted it a special distinction of physiological science that it was charged with the obligation of studying this mystery. In his eloquent tribute to physiology as a science Huxley compared it with the Atlantic Ocean stretching between the old and the new world: "its waves wash the shores of the two worlds of matter and of mind"; and Du Bois Reymond claimed that "Physiology is the queen of the natural sciences because it leads us to the last of problems, because it is the science that deals with the conditions of consciousness."

Our generation has not, as yet, concerned itself to any great extent with such problems. Consciousness we have left to the psychologists, but it cannot be said that either their experimental or their introspec-

tive methods have been successful in adding anything of real significance to our knowledge of this matter. The connection between brain activity and its psychical response remains a profound mystery for which neither philosophy nor science has been able to suggest an adequate explanation. The objective methods of behaviorism offer a new avenue of approach which is promising, at least, as a means of increasing the number of verifiable data concerning consciousness, and physiology itself is beginning to make an application of its special methods to the same end. Pavlov's work upon conditioned reflexes has provided a technique through which we may hope to study profitably the cerebral reactions that are connected with the acquisition of new knowledge, a problem that formerly seemed unapproachable by any experimental means. The full exploitation of this method will no doubt greatly increase our understanding of the processes of mental training and will eventually find an application to our systems of education.

The other great problem of heredity that belongs also to what Bernard called the "irreducible residuum" to which the methods of physics and chemistry did not seem to apply, although unaccountably neglected by the physiologists, has begun to yield its secrets, thanks chiefly to the researches of the botanists, cytologists, and geneticists. While the directive influences which guide the development of the fertilized ovum are not understood, a surprising amount of information has been acquired during our generation in regard to the mechanism of the process and the structure and properties of the substance

which exhibits these marvelous reactions. It has been located in the chromosomes of the reproductive cells, something of its chemistry is known, and its arrangement in a linear series of genes, each with a given potentiality of development, has been demonstrated by experiments. The work of Mendel, De Vries, Morgan and others has made it possible to formulate certain laws of heredity, and to control the process of development itself, to the extent at least of producing definite mutations. Genetics has become established as an experimental science with a technique peculiar to its needs, but in its further development it will no doubt find the opportunity and necessity of employing the methods of physics and chemistry, in every possible degree of refinement, and its problems will be distributed, as are those of other physiological processes, among workers in many fields and with many different varieties of training.

In the field of animal physiology we have followed in the main the course laid down by Bernard. We have given ourselves almost entirely to an experimental study of the mechanisms of the body and the physical and chemical properties of living substances, under the conviction that this groundwork must be securely laid as a foundation for the study of the more difficult general problems. This attitude toward our subject has, perhaps, made it less interesting to the general public. Mankind is more intrigued by the high peaks of speculation with its sweeping generalizations that take in everything to the uttermost horizon at a glance, as from a mountain-top, than by the low roads of laborious research which push their

way patiently toward the final goal. Witness the great access of interest in the subject of astronomical physics that has attended its recent flights into the regions of the unknown.

In the biological sciences the center of the stage during our generation has been held by the observational and morphological branches, since they have indulged in a greater freedom of speculation regarding the processes of living nature. Physiologists have contented themselves with the task of accumulating reliable data. This task has turned out to be more difficult than was anticipated by our predecessors. They felt that the mechanical methods of research applied to the study of protoplasm would soon reveal the secrets of its structure and enable us to build up living substance out of inorganic material. We entertain, I imagine, the same general belief, but we realize that it is an enormously difficult task which will not be accomplished in any short period of time. One of our immediate present problems is to discover the structure of the protein molecule. When this is solved we may be on our way to a comprehension of the more difficult matter of the organization of living structure. So far as we can see there is no factor in the problem that cannot be met by an application of the experimental method, but no one can prophesy how long it will be before the goal is reached. And when one goal is passed there will be others, doubtless, farther on for whose attainment, possibly, the experimental method may not suffice. The synthesis by laboratory methods of a self nourishing protoplasm, that might be designated as living matter, is

conceivable, but the organization of that matter into the structure of a cell or the complex unity of a multicellular organism may well require time and conditions that cannot be compassed by human experimentation.

Meanwhile the policy that we are following in physiology as in the other exact sciences is to push our experimental methods to their farthest possible limit. No one can foretell all that they may accomplish. Time and again when an end has seemed to be in sight new ideas and new methods have been discovered which have extended widely their possibilities.

During the past twenty-five or thirty years the content of physiological knowledge has been largely made over by the accumulated results of the labors of thousands of devoted workers in this and other countries. In no branch of the subject is this growth more apparent than in the field of the internal secretions, in the development of which the researches of Dr. Cannon and his co-workers have constituted such an important factor. The combined labors of the experimental physiologist and the biochemist have brought to light many of the hidden functions of these curious structures, and have given us new ideas and problems in regard to the hormonal regulation of the animal economy. It might have been anticipated that such a complex and sensitive structure as the animal body would require exquisite means of adjustment to maintain its unity in the face of a constantly changing environment, but the story as it has been unfolded is full of unexpected revelations. By a con-

tinuation of such experimental researches we shall be in a fair way to reach a full understanding of this complex system of chemical regulation of the body, and in proportion as our knowledge increases we shall be able to supplement more and more the natural mechanisms by the artificial devices of science.

It would be an interesting task for a physiologist to trace, step by step, the many changes that have taken place in the subject during the past quarter of a century, to summarize the new facts that have been added and the new interpretations of old data, but it would be a long story sufficient to fill a good sized volume. At times we have benefited by the adoption of new methods, borrowed from other sciences, which have placed in our hands means of research of an especially helpful kind, and have greatly widened our knowledge and changed our points of view. The introduction into our work, for example, of the methods of physical and colloidal chemistry has given us new conceptions and a new terminology with which to study the interplay of matter and energy between the cells and their environment. Our modern theories of reaction and physico-chemical equilibria and energy potentials have come to us through these new sciences. In such matters we speak a different language from that used by our predecessors. In other cases new facts, new discoveries have arisen which have completely changed the aspect of some of our old problems. In heart-physiology, for instance, the discovery of the nodal tissues and the conducting system has given us a new attitude toward the interpretation of the cause and sequence of the heart beat.

So also in the matter of nutrition. The splendid work of the preceding generation had laid a solid and apparently satisfactory foundation for the understanding of the metabolic processes of the body. It had demonstrated beyond question that the laws of conservation of matter and of energy apply to the phenomena of growth and assimilation exhibited by living matter — a notable triumph, indeed, for the mechanists in their interminable controversy with the vitalists. And then came the discovery of vitamins and of the specific influence of certain inorganic substances, which showed how incomplete had been our former premises and how much we have still to learn in regard to the nutritional changes that go on in living things.

In every part of physiology during this short period changes of this kind have been taking place. When we look back and compare our knowledge then and now we can be well satisfied with the progress that has been made, and can anticipate that the continued application of our present methods of research will bring us richer returns in the years to come. I am confident that this laboratory under the inspiration of its able leader will play an important part in the future, as it has done in the past, in bringing these hopes to realization.

EXERCISES IN THE EVENING

THE LIFE OF A PROFESSOR

Graham Lusk, M.D.

Samuel Johnson has told us that "nobody can write the life of a man but those who have eat and drunk and lived in social intercourse with him." I have not lived with Cannon, but I have eaten with him. I may have drunk with him in the good old days, but of late that pleasure has been denied to both of us. In spite of these limitations, I am to speak of him tonight in relation to the life of a professor, and I do so because rules and regulations ought not to hamper a professor's wishes. It was said of Gorraeus, who lived in the sixteenth century, that he possessed the two things needful to make a good physician — he knew Greek well and he had a perfect knowledge of the secrets of nature. I do not know how much Greek Cannon knows, but I here bear witness to his perfect knowledge of the secrets of nature.

For nearly a third of a century our friend who is the guest of the evening has taught physiology at the Harvard Medical School, and for the past twenty-five years he has been professor of physiology in this very important school. Stimulated by Bowditch he began his work upon the movements of the alimentary canal in 1897 while he was still a first-year medical student. The transmission of knowledge and inspiration from master to pupil is often too little recognized in its true historical perspective, for the older generation passes into comparative oblivion and the newer generation stands forth in virility and strength. The

other day I found a paragraph written by Liebig in 1840 containing the words which were constantly used by Voit in his lectures and have been as constantly repeated by me. So for ninety years the thoughts of Liebig have been transmitted to others by word of mouth. In like manner our friend Cannon is a branch of the stem of Bowditch, who was a branch of the stem of Carl Ludwig. Thus the spirits of those who have gone before emerge in the actions, thoughts, and words of our own day and generation.

I well recall a visit to Boston, made many years ago on the occasion of a meeting of the American Physiological Society, of which Bowditch was then president. A young student by the name of Cannon had placed a trained live goose in a frame and had thrown the newly discovered Roentgen rays so that they passed through the goose's neck. The animal was made to swallow a small pellet of corn meal mush mixed with bismuth and about the size of a shoe button. One could see the even movement of the pellet through the gullet of the goose. The movement was at first more rapid and then less so. About 12 seconds elapsed for its complete passage through the neck of the goose. Meltzer discussed the mechanism so perfectly revealed. I have told the story to every class that I have taught. I am sure Dr. Howell has done the same, and many others who saw the experiment have also told the story. And countless thousands who have read standard textbooks on the subject have been presented with this convincing picture. When a young man has participated in the uncovering of new truth he becomes a different person. He

has gained a mastery over a given subject which before his time had been denied to others. He has acquired a thirst for a knowledge of the reasons why things are. Anyone can run a trolley car, but it requires expert knowledge in the power-house to understand why the wheels go around. So Cannon early acquired a thirst for knowledge of why the wheels go 'round in the animal body. It is people who acquire this habit-forming kind of intoxication who make the best professors in our medical schools. One piece of research in Cannon's life led to another, as is natural to the man who gives his life to inquiry into nature by way of experiment.

On the occasion of a banquet given in honor of his seventieth birthday Helmholtz told his hearers that he had never had a great thought come to him at his desk or when he was tired or after he had had a glass of wine, but usually when he had been walking in his garden thinking of other things. It was then that a kaleidoscopic rearrangement of already acquired information took place and a new vision revealed itself. The great chemist von Baeyer stressed this point in a printed lecture. It is more than forty years ago since I frequently encountered von Baeyer walking alone on Sunday mornings in the gardens of the Isar Anlagen, for his own intellectual as well as physical refreshment.

Now we find these elements in Cannon. He has not allowed his mental processes to be overwhelmed by impossible burdens of administrative detail, he has surrounded himself with highly capable men individually fully able to conduct independent laboratories

of their own and has bound them to him with fetters of affection and esteem. In this way he has been able to rest when he was tired, to walk in his garden with freedom of spirit among flowers planted and tilled with his own hands, and like Helmholtz to cultivate his mental garden at the same time.

A. V. Hill, on his last visit to New York, said, "I want you to put a motto on the walls of this laboratory — which you will not dare to do — to read, 'It is better to work too little than to work too much.' There is need to preach such doctrine in the laboratories of America." And Hadley told me many years ago that the great work of the world was done by men who were a little lazy and had good consciences. Such men would not work for the love of being employed, often in time-consuming endeavors upon subjects which were not worth while; but if after due meditation they saw a thing was worth doing, their conscience would drive them to make the effort and to accomplish the task. These did the greatest work.

When one looks over the efforts of Cannon's life one finds a very great amount of discovery which was carefully planned and well worth while. If he be a little lazy — I do not know, I only put the hypothetical question — why it only bears out the doctrine of a great president of Yale University. Hadley told me this many years ago, before he became president of Yale, on an evening when he and Theodore Woolsey and I were drinking beer together at Heublein's restaurant in New Haven. It was purposely planned on an evening of a Harvard-Yale boat race at New London. When the students began to return we pro-

fessors went home. And in later life he reaffirmed to me his allegiance to this doctrine, though I doubt if he ever gave public expression to it.

I recall that Bowditch told me that the Boston Public Library was the product of the use of public funds of the City of Boston by a committee of public-spirited citizens, which included Bowditch himself, and that so much money was saved through the absence of political interference that the greatest artists of the day could be called upon to decorate the walls of that library. Sargent and Abbey, intimate friends, worked together while producing their masterpieces, and Puvis de Chavannes has said that his best work was in Boston. No other building, public or private, has thus been endowed in America, although medieval Italy is full of such treasures betokening wealth and appreciation of beauty. It was Giovanni Rucelli who thanked God that he "was a native of Florence, the greatest city in the world, and lived in the days of the magnificent Medici." It is of happy significance that the professor of physiology, Bowditch, had a hand in the building of Boston's public library and he doubtless thanked God that he was born in Boston.

Likewise the public services of Cannon have been eminent. He has valiantly espoused the necessary right of the laboratories to perform vivisections upon animals, his record during the war is one of devotion to humanity, and his recently remembered part in the last International Physiological Congress brought him universal acclaim.

During the war he became successively first lieutenant, captain, major, and lieutenant colonel. Re-

search into the cause of shock and the application of knowledge for the benefit of wound-shocked soldiers were his themes. He became chairman of the committee which organized the meetings of the Red Cross Medical Research Society established in Paris in 1917. In 1918 he gave the Croonian lecture before the Royal Society in London. In 1919 the British Government conferred upon him the Cross of the Companion of the Bath for "meritorious services for the Allied cause." Our own government gave him the Distinguished Service medal in 1922. This record does not substantiate the hypothesis that wars are fought for purely economic reasons. Certainly a man in Cannon's position did not expose himself to shell fire in order to save Wall Street banks from destruction, all the sophistry of the historians to the contrary notwithstanding. There were deeper, more fundamental reasons.

The International Physiological Congress which met here in Boston during the summer of 1929 brought men of many lands together in the happiest kind of way. At a ceremonial dinner Cannon presided in such a manner as to win for himself and for his country deserved foreign recognition. My old and honored friend Max Rubner, of Berlin, wrote me concerning a conversation he had had with his former assistant Karl Thomas, now professor of physiological chemistry at Leipzig, after his return from the Congress. He wrote:

> Thomas called on me immediately after his return from America and brought me good news. I rejoiced over his expression of opinions, which are entirely in accord with

my own. In Europe, America is considered as exclusively a land of the dollar. But that is fundamentally false. I have myself seen that in wide circles of society there is no chasing after dollars, and that there is a widespread earnest endeavor in science without thought of money, and that much effort, especially in the young, is dedicated to science in spite of the penurious salaries which are paid.

This takes us back two hundred years, to Samuel Johnson's *Imitations of Juvenal*, for, in the Tenth Satire on the vanity of wishes for literary distinction, one may read:

> Yet think what ills the scholar's life assail,
> Toil, envy, want, the garret and the jail.

One should recall that in those days imprisonment for debt was still in vogue.

Lest this be considered too grotesque a picture, let us remember that within the memory of many here Columbia University appointed a committee to inquire into the condition of those members of her teaching staff whose families were in need of the necessities of life. Chittenden recalls that in the days of the chemist Benjamin Silliman it was thought at Yale that chemistry, like virtue, should be its own reward.

A German friend has recently written me, "The research workers in the institutes for pure research are egotists or they become such, whereas teaching institutions can retain men only when they are altruists." It is the living vibrating voices of altruistic men which make a university. Byron, contemplating the Palace of the Caesars adjoining the Roman Forum, wrote:

> . . . Temples, baths, or halls?
> Pronounce who can; for all that Learning reap'd
> From her research hath been, that these are walls —
> Behold the Imperial Mount! 'tis thus the mighty falls.

But of the men of Greece he says:

> While kings in dusky darkness hid
> Have left a nameless pyramid
> Thy heroes through the general gloom
> Hath swept the column from the tomb,
> A mightier monument command,
> The mountains of their native land!
> There points thy Muse to stranger's eye,
> The graves of those who cannot die.

Thus the deeds of men of intellect may survive longer than the accomplishments of carpenters and masons. A university is a fellowship of scholars, not a mass of stones and bricks.

We have come here tonight to do honor to a great member of such a fellowship of scholars, one who is a truly great teacher and a great professor. On such men depends the welfare of our modern world. They are indispensable. Their care and nurture, as well as the hatching of gifted young successors, is the concern of the whole country to which they properly belong. The primary aim of American universities has lately seemed to be the comfort and welfare of the student body. This tendency should be eradicated from the minds of wealthy donors. A real student can live on very little money. This American educational world of ours will not be properly balanced until the American professor is recognized by the donors to the universities as one whose personal comfort and welfare are of paramount importance in the scheme of things.

The wealthy donors to the universities are great men, good men, men of high principles and actuated by high motives. What they need is a concerted effort on the part of the universities to educate them. They should be instructed that the modern student body itself desires great teachers, even before it receives great buildings, which latter may be more of a liability than an asset. A wicked wag, let us hope a New Yorker, has lately stated that the intellectual caliber of a medical faculty is in inverse proportion to the height of the building which it occupies. It is certain that buildings alone will not make men great.

The education of a patron of art and learning is a very old story. An encounter between Beethoven and Goethe may be cited in illustration. Beethoven was a rough fellow with few manners, whereas Goethe was essentially a courtier and was offended when Beethoven spoke to him as follows:

> I told him [a grand duke], "You may pin an order to anyone's breast and he will not be the better for it. You may bestow the title of Hofrat or Geheimrat but you will never make a Goethe or a Beethoven either. You must learn to appreciate what you yourself are unable to create. It will be good for you."

We must all appreciate the great difficulties in the way of a common understanding between the patron and the scholar or the artist. Perhaps as a class professors are too reticent in their educational world, especially when it comes to the matter of their own well-being. They are true altruists. Their welfare is, however, of great public concern. If by outsiders they are held to be small and narrow, is not the fun-

damental cause due to the fact that their means have compelled them to live narrow and restricted lives?

But in spite of our system some professors have lived lives of great and notable accomplishment. We in America are proud to have in Dr. Cannon a representative of the best that there is in us. His colleagues, associated with him for many years in common hopes and aspirations, have come from far and near to pay tribute to the wisdom, the power, and beneficence of his influence upon his time. We are all grateful to him for what he has accomplished for the welfare of mankind, and in the name of all his friends we wish him continued health, that he may continue in the joy of his search after the secrets of nature.

PRESENTATION OF DR. CANNON'S PORTRAIT TO THE UNIVERSITY

PRESIDENT A. LAWRENCE LOWELL:

Dr. Cannon's work belongs to the world, but there is something that belongs to us, and that is Dr. Cannon. Some of his friends have wanted to perpetuate him as he has appeared to us. I will ask Dr. Drinker to present his portrait.

DR. CECIL K. DRINKER:

About a year and a half ago, Dr. Christian, who has a way of remembering such things, called the attention of some of us to the fact that this fall Dr. Cannon would complete twenty-five years of service as a Professor in the University and those of us who had been associated with him should do something about it. We, as a small committee, decided to have his portrait painted and to present it to the University this fall with exercises appropriate to the occasion. When Dr. Cannon was informed of this sentence, he made one condition: that he wished the portrait to be painted at work in the laboratory, since as he looked back on these twenty-five years he could really feel certainly proud of but one thing, that he had worked hard. The committee selected Mrs. Maria Danforth Page to paint the portrait. She fell in with Dr. Cannon's suggestion readily and we believe most successfully. Perhaps the coat is somewhat more respectable than the one we generally associate with Dr. Cannon, but time can be counted

upon to take care of that. It must be a pleasure to you, Dr. Cannon, to know that the portrait is a gift to the University from 307 of your former students and associates. No one was permitted to give much. Subscriptions were received from all over the world and in sufficient amount to enable us to have made an excellent photograph of the portrait, which will be sent tomorrow to all the donors. It is a great pleasure, Mr. President, on behalf of our small committee and the donors, to present this portrait to you as the representative of the University.

ACCEPTANCE OF THE PORTRAIT FOR THE UNIVERSITY

President A. Lawrence Lowell

It is a pleasure on behalf of the University to accept this portrait, to be hung here among our collection of men who have been notable and who have made great contributions to medicine in the past. The art of life consists not so much in solving problems as in finding the problems to be solved; and the selection of a man's work in life has much to do with his greatness.

I take it that the progress of all science has been from structure to function. The earliest work of astronomy was finding out what the motions of the heavenly bodies were, and that was brought to a climax when the heliocentric theory was developed; but as yet they were studying structure. Then came Newton with his theory of gravitation, which might be said to be the study of function — that is why the planets move in the way they do. Surely this has been true of all sciences, except those of which the structure could not be observed at all, but could only be inferred from the function, such as chemistry and electricity, and I suppose that is why chemistry and electricity have been so late in their appearance among the sciences.

Now the same progress has been true of anatomy. It had to be studied before physiology could begin. But this is the day of function in all directions, and physiology is the study of the function of living

tissues. It is that to which Dr. Cannon has devoted himself. He came under the lead of Dr. Bowditch just at the time when physiology was beginning to make its real advance, and he has moved with this advance throughout his life. To my mind, the great thing that he has done is finding out the problems to be solved; and he has solved problem after problem, each rising out of another. The first I remember about Dr. Cannon was his feeding cats on bismuth, which he did for the purpose of discovering the operations of the intestinal tract, and from that he has gone on from one subject to another, always seeing ahead a new problem to be solved.

It would be absurd for a layman to discuss what the world knows of his greatness. There is one serious defect in that picture — that the figure is receiving light instead of radiating it.

CLOSING REMARKS

Walter B. Cannon, M.D.

Mr. President, my Colleagues and Friends:

As I have listened to what has been said concerning me and my work this afternoon and this evening, I have been reminded of a conversation which I had years ago with Thomas Salmon, the psychiatrist. Dr. Salmon once had a rather select acquaintance with some of the more important members of the society which dwelt at that time in Sing Sing prison. It was characteristic of these prisoners that they were not wholly satisfied with the judgment that was passed upon them. Dr. Salmon told me that not infrequently one of these men would regain a conviction of innocence and a rather satisfactory serenity — indeed, at times, a comfortable feeling of being a martyr — by the simple expedient of persuading himself that he was not the sort of person that people thought he was. In short, they had caught the wrong man! The situation, of course, remained rather hard on the man, but at least he had a clear conscience.

I am quite willing to admit that a teacher and a worker in science might *seem* to be properly described by such kind and generous terms as have been used today by my friends. But in a sense, I really believe they have caught the wrong man. I say that with the warmest possible appreciation of the very friendly judgments which they have passed upon me — and, I may add, with a rather pleasant feeling of release

from the necessity of living up to the high estimate which they have expressed.

After all, what a worker accomplishes depends very largely on the conditions under which he labors. In my own instance, those conditions have been extremely favorable. I have been associated throughout my scientific career with a University which has been a real alma mater. The authorities who have directed her policies have been not only liberal and considerate, but have been — what is quite as important — understanding and appreciative. I am very glad indeed to have this opportunity to express to President Lowell and to Dean Edsall my very profound gratitude for all that they have done in administrative and encouraging ways to make the Department of Physiology a place where productive scholarship could be conducted in an effective manner.

Again, how much a man of science owes to association with his colleagues! Who could work alongside of Drinker, Forbes and Redfield, Bremer and Lewis, Zinsser and Wolbach, Folin, Hunt and Rosenau — to name only a few of my nearest colleagues — who could work alongside of these men without gaining much from them? Bremer has helped me many times in questions of histology; Zinsser has always been stimulating, in educational and biological ways; with Wolbach, pathology and physiology are so closely knit as to make him invariably useful to the puzzled physiologist; Hunt I can recommend to you as an encyclopedic source of knowledge whenever you are in need; Folin has given me aid innumerable times by suavely and coldly disposing of a very beau-

tiful physiological idea by a very ugly biochemical fact! If the work done in the Department of Physiology has had at times significance and values for practical medicine, the credit for that must largely go to my very happy relations with Cushing and Christian and their associates at the Brigham Hospital, and to the opportunities for conference offered at the Children's Hospital. Not only does one owe much to one's colleagues, but they help to bind him with strong and pleasant bonds to the place where they are. The company of scholars which constitutes a University is held together by ties of fellowship and understanding which are hard to break at any time and which hold more firmly as the years go by.

Not only colleagues, but students! How much of the output of the scientific worker results from contacts, from conversations, from discussions, from the give-and-take of criticism and rebuttal, which he has with his students! I have long held the view that teaching is helpful to an investigator. He expounds his subject to men — in the Medical School to well-trained men — who look at the facts from a new angle. Hardly a year passes that I do not receive a novel suggestion as a result of my talks to first-year medical students. And advanced students are a veritable mine of resources of all sorts. Some of you may recall a reliance which I have placed on a whimsically wise remark of the late Josiah Royce. He said that you could always depend on the "fecundity of aggregation." Now, that is an eminently true remark. All you have to do is to gather men together in a group and something new will emerge from the group,

merely because the men are so gathered. That is the advantage which develops when a department becomes a place where eager young workers in science congregate. New ideas, new methods, new facts emerge from the group — and the head of the department gets undue credit.

It wouldn't be quite fair if I didn't testify as to the values which come to an investigator because of his own blundering. Horace Walpole thought that we should add a new word to the language — "serendipity" — a word suggested by the story of the three princes of Serendip, who went about the world making accidental discoveries. Many of the observations which we have published from the laboratory are instances of serendipity, true gifts of chance. They should not be credited to our sharp insight; they have really been the outcome of what has incidentally appeared in the course of the experiments. And the perspicacity was quite ex post facto.

Well, I hope that I have been able to convince you that today I have served as a figure of speech — I think the old rhetorics called it a "synecdoche" — a part used to represent a whole. What William James would call my "scientific me" is made up of many influences and supports — from my University, my colleagues, and from fellow students — all helpful and necessary factors in anything I have done, and they should not be overlooked.

Perhaps you will allow me an incidental remark concerning the portrait. Whether it is a good likeness or not, you can judge better than I. I told the artist if I didn't look like that, it is the way I should like to

look. When the portrait was first proposed, as Dr. Drinker has told you, I requested that I be represented as I am at work. Before the artist began, I had the notion that the laboratory coat was a drab affair of a greenish brown color; but as seen and depicted by the artist it soon began to have all the tints from green to gold, and finally it appeared that Solomon in his official regalia could probably not have been arrayed more royally than one of us as we dress for work in our laboratories. Possibly this portrait will be known not only as a likeness, but also as a glorification of the laboratory coat.

I do not wish this occasion to pass without a few words regarding the career of a teacher and investigator. More than a third of a century has passed since my first publications in physiology, and it was thirty-two years ago that I first became an Instructor in Zoölogy, with Dr. Parker in Cambridge. That is a long time. Think what an extraordinary arrangement it is that during that period I have been permitted to do the sort of work that I had rather do than anything else in the world, and in addition have received a livelihood for myself and my family! That seems to me an ideal existence.

During that long period, many students have marched past me. They are now widely scattered over the world. As they have increased in numbers I do not recall their faces as distinctly as I did in the earlier years of teaching, but it is a very pleasant thought that they remember me. A most cordial reception from old students in Seattle — a joyous shout from a medical officer in a dug-out in France — a

hand wildly waved from a passing cab in a crowded London street, a cab that was instantly stopped and emptied of its occupant, who came rushing toward me — an adventurous night ride with a welcoming group over the Minnesota prairies from St. Paul to Rochester — these are some of the evidences of remembrance and regard which as a teacher I cherish. We are advised in the Bible to cast our bread upon the waters and we are told that we shall find it after many days. When I was a student in Sunday School that never seemed to me a very appetizing prospect. It was only after I became a teacher that I realized that there is a miracle that happens — you cast your bread upon the waters and what you find after many days is buttered toast!

Besides the medical students there are the research students — the men who go out to teach and to carry on productive scholarship. Some of you know that I like to regard my relations with these men not in the simile of a tree, as Dr. Lusk has suggested, but as members of a family. Just as I am the grandson of Ludwig in scientific inheritance, and the son of Bowditch, so I am now the father of a scattered brood in Belgium and Holland, in Spain, in Argentina, in Brazil, in Mexico, and in various universities of the United States. It is a great satisfaction — one of the greatest satisfactions in the career of an investigator — to realize that he is a member of a large and growing family, for some of my sons now have sons themselves, and I am, therefore, a proud grandfather.

One of the choicest rewards of the investigator's career is the realization that he has the sympathetic

understanding and the cordial good will of other workers in science — men who have lived the life of a man of science, who know something of its difficulties, who have experienced its thrilling moments when new discoveries are made, who have felt the gratification which comes when they have been able to add a bit to the accumulation of the "durable results of the perishable years." I wish to express my deep thankfulness to my fellow workers in physiology — Dr. Alvarez, Dr. Lusk, and Dr. Howell — for their great kindness in coming here and for their very encouraging words.

And may I thank you all, my friends, for this inspiring tribute of appreciation. To the end of my days, I shall carry the happy memory of it as a cheering thought.

President Lowell

There would seem to be one person here present who doesn't wholly appreciate Dr. Cannon. Dr. Cannon, let me introduce you to the great Professor Cannon. He is a very modest gentleman, but you will find him worth knowing.

If you have appreciated this occasion half as much as we have, if you have enjoyed it half as much as we have enjoyed bringing to you our tribute of affection, this meeting has been a great success.

THIRTY-FOUR YEARS

WAR SERVICE

Commissions:

First Lieutenant, April 21, 1917.
Captain, August 11, 1917.
Major, February 10, 1918.
Lieutenant-Colonel, October 23, 1918.

April 21, 1917–June 23, 1917, Director of the Laboratory, U. S. Base Hospital No. 5, in British Service at Camiers, France.

June 23, 1917–October 23, 1917, at No. 33 Casualty Clearing Station, Bethune, France; Collaborating with Captain John Fraser, Captain E. M. Cowell, and Captain A. N. Hooper in Studies of Shock and Hemorrhage.

August, 1917, Member of the English Committee on Shock, Formed by Professor W. M. Bayliss.

October 23, 1917–February 15, 1918, Physiological Laboratory, University College, London; Continuing, with the Help of Professor Bayliss, Experiments on the Nature of Wound Shock and the Effect of Cold on Blood Pressure.

1917–1918, Chairman, Red Cross Medical Research Society, Paris.

February 15, 1918–April 1, 1918, Interallied Conference on Gas Warfare, Paris.

April 1, 1918–December 25, 1918, in Charge of a Laboratory for Surgical Research, Established by General J. H. T. Finney, at the Central Medical Department Laboratory, Dijon, France. During this Period, President of the Anglo-American Medical Society.

DECORATIONS

Companion of the Bath, England, 1919. Conferred for "Meritorious Services for the Allied Cause."

Distinguished Service Medal, U. S. A., 1922.

MEMBERSHIPS AND CONSULTING POSITIONS

Phi Beta Kappa, 1895.

Fellow, American Association for the Advancement of Science, 1904.

American Physiological Society, 1900.
Treasurer, 1905–1912.
President, 1914–1916.

Society for Experimental Biology and Medicine, 1904.

Phi Rho Sigma, 1905.

Alpha Omega Alpha, 1906.

American Academy of Arts and Sciences, 1906.
Vice-President, Class II, 1931.

Boston Society of Medical Sciences.
President, 1908.

Massachusetts Medical Society, 1904.

American Medical Association, 1905; Fellow since 1913.
Member of Council on Health and Public Instruction, 1911–1922.
Chairman, Committee for the Protection of Medical Research, 1908–1925.

American Gastroenterological Association, 1907.
President, 1910–1912.
Honorary Member, 1926.

American Philosophical Society, 1908.

Harvey Society, New York City, Honorary Member, 1911.

American Psychological Association, 1912.
Associate Member, 1925.

Consulting Physiologist, Peter Bent Brigham Hospital, 1912.

Chairman, Commission on Electric Shock, National Electric Light Association, American Institute of Electrical Engineers and The American Medical Association, 1912–1913.

American Roentgen Ray Society, Honorary Member, 1913.

Consulting Physiologist, Boston Children's Hospital, 1914.

Chairman, Commission on Resuscitation from Mine Gases, U. S. Bureau of Mines, 1914.

National Academy of Sciences, 1914.
Chairman, Division of Physiology and Pathology, 1915–1928.
Member of Council, 1928–1931, 1931–

New York Roentgen Ray Society, Honorary Member, 1914.

Association of American Physicians, 1914.

Trustee, Elizabeth Thompson Science Fund, 1915.
Secretary, 1916–1922.

Société de Biologie, Paris, Corresponding Member, 1919.

Corporation and Board of Directors, Robert S. Brigham Hospital for Incurables, 1921–1924.

Charter Member, Association for the Study of Internal Secretion, 1921.
President, 1921–1922.

Committee for Research in Problems of Sex, National Research Council, 1921.

Vice-President and Chairman of Executive Committee, Ella Sachs Plotz Foundation, 1921. One of Original Members.

Reale Accademia della Scienze, Bologna, Corresponding Member, 1921.

Sociedad de Biologia, Buenos Aires, Honorary Member, 1922.

Chairman, Committee on Pernicious Anemia, Harvard University, 1927–1929.

Commission on Epilepsy, Harvard University, 1928.

Société Belge de Giologie, Brussels, Associate Member, 1929.

Société de Psychologie, Paris, Associate Member, 1930.

Royal Society, Edinburgh, Foreign Honorary Fellow, 1930.

American Psychopathological Association, Honorary Member, 1931.

LECTURER

Wesley Carpenter Lecturer, New York Academy of Medicine, 1914 and 1923.

Croonian Lecturer, Royal Society, London, 1918.

First Lecturer, Wisconsin Alumni Research Foundation, 1929.

Linacre Lecturer, Cambridge University, 1930.

BIBLIOGRAPHY

1897

On the Determination of the Direction and Rate of Movement of Organisms by Light. C. B. Davenport and W. B. Cannon. J. Physiol., 1897, XXI, 22–32.

1898

The Movements of the Stomach Studied by Means of the Röntgen Rays. Am. J. Physiol., 1898, I, 359–382, xiii.

The first account of this work was given at the meeting of the American Physiological Society, in May, 1897. See, Science, 1897, V, 901.

Also, J. Boston Soc. of Med. Sci., 1898, II, 59–66. Presented to the Boston Society of Medical Sciences, February, 1898.

Translated into French: Les mouvements de l'estomac étudiés au moyen des rayons Rontgen. Poitou méd., 1899, XIII, 11–22.

The Movements of the Food in the Oesophagus. W. B. Cannon and A. Moser. Am. J. Physiol., 1898, I, 435–444.

1900

The Use of Clinic Records in Teaching Medicine. Bull. Am. Acad. Med., 1900–02, V, 203–213.

Read before the Association of American Medical Colleges, Atlantic City, N. J., June, 1900.

The Case Method of Teaching Systematic Medicine. Boston M. & S. J., 1900, CXLII, 31–36.

The Case System in Medicine. Boston M. & S. J., 1900, CXLII, 563–564.

Read at a meeting of the Boston Society for Medical Improvement, March, 1900.

1901

Intracranial Pressure after Head Injuries. Boston M. & S. J., 1901, CXLV, 158–161.

Read by invitation at the Annual Meeting of the Massachusetts Medical Society, June, 1901.

Cerebral Pressure Following Trauma. Am. J. Physiol., 1901–02, VI, 91–121.

1902

The Movements of the Intestines Studied by Means of the Röntgen Rays. Am. J. Physiol., 1901–02, VI, 250–277, xxvii.

The results of this investigation were reported to the Boston Society of Medical Sciences, November, 1901.

Also, J. Med. Research, 1902, n.s., II, 72–75.

1903

Observations on the Mechanics of Digestion. J. A. M. A., 1903, XL, 749–753.

Read at the Fifty-third Annual Meeting of the American Medical Association, in the Section on Pathology and Physiology, Saratoga Springs, N. Y., June, 1902.

Further Observations on the Movements of the Stomach and Intestines. Proc. Am. Physiol. Soc., 1902–03, VIII, xxi.

Demonstration of the Movements of the Stomach and Intestine, Observed by Means of the Röntgen Rays. Am. J. Physiol., 1902–03, VIII, xli.

Salivary Digestion in the Stomach. W. B. Cannon and H. F. Day. Am. J. Physiol., 1903, IX, 396–416.

A preliminary report of this research was presented at the Fifteenth Annual Meeting of the American Physiological Society, Washington, D. C., December, 1902. See, Proceedings, This Journal, 1902–03, VIII, xxviii.

1904

The Passage of Different Food-stuffs from the Stomach and through the Small Intestine. Am. J. Physiol., 1904–05, XII, 387–418.

A partial report of this research was presented at the Sixteenth Annual Meeting of the American Physiological Society, Philadelphia, Pa., December, 1903. See, Proceedings, This Journal, 1903–04, X, xvii.

1905

Observations on the Alimentary Canal after Splanchnic and Vagus Section. Proc. Am. Physiol. Soc., 1905, XIII, xxii.

The Passage of Different Food-stuffs from the Stomach. J. A. M. A., 1905, XLIV, 15–19.

Read at the Fifty-fifth Annual Meeting of the American Medical Association, in the Section on Pathology and Physiology, Atlantic City, N. J., June, 1904.

Gastro-Enterostomy and Pyloroplasty: An Experimental Study by Means of the Röntgen Rays. Walter B. Cannon, M.D. and John Bapst Blake, M.D. Ann. Surg., 1905, XLI, 686–710.

Recent Advances in the Knowledge of the Movements and Innervation of the Alimentary Canal. Med. News, 1905, LXXXVI, 923–929.

Presented at the Eighth Annual Meeting of the American Gastro-enterological Association, New York, April, 1905.

Auscultation of the Rhythmic Sounds Produced by the Stomach and Intestines. Am. J. Physiol., 1905, XIV, 339–353.

The first results of this investigation were presented at the Eighth Annual Meeting of the American Gastro-enterological Association, New York, April, 1905.

The Ideals of the Man of Science. The Christian Register, 1905, LXXXIV, 1192–1195.

Further Observations on the Mechanism of the Pylorus. Proc. Am. Physiol. Soc., 1905–06, XV, xxv.

1906

Recent Advances in the Physiology of the Digestive Organs Bearing on Medicine and Surgery. Am. J. M. Sc., 1906, CXXXI, 563–578.

The Movements of the Stomach and Intestines in some Surgical Conditions. Walter B. Cannon and Fred T. Murphy. Ann. Surg., 1906, XLIII, 512–536.

The results of this investigation were presented before the Boston Society of Medical Sciences, November, 1905.

Also, Am. J. Physiol., 1905–06, XV, xxv.

The Rhythmic Sounds of the Alimentary Canal. J. A. M. A., 1906, XLVI, 171–174.

Read at the Fifty-sixth Annual Meeting of the American Medical Association, in the Section on Pathology and Physiology, Portland, Ore., July, 1905.

Dr. R. C. Cabot's "Case Teaching in Medicine." Harvard Graduates Magazine, 1905–06, XIV, 609–610.

The Motor Activities of the Stomach and Small Intestine after Splanchnic and Vagus Section. Am. J. Physiol., 1906–07, XVII, 429–442.

A preliminary report of this investigation was presented at the Seventeenth Annual Meeting of the American Physiological Society, Philadelphia, Pa., December, 1904. See, Proceedings, This Journal, 1905, XIII, xxii.

Presented at the Eighteenth Meeting of the Society of Experimental Biology and Medicine, New York, 1906. See, Proceedings of the Society, 1906–07, IV, 3–5.

On the Motor Activities of the Alimentary Canal after Splanchnic and Vagus Section. Abstr. Science, 1906, XXIV, 764.

1907

Oesophageal Peristalsis after Bilateral Vagotomy. Am. J. Physiol., 1907, XIX, 436–444.

Physiologic Observations on Experimentally Produced Ileus. W. B. Cannon, M.D. and F. T. Murphy, M.D. J. A. M. A., 1907, XLIX, 840–843.

Read at the Fifty-eighth Annual Meeting of the American Medical Association, in the Section on Surgery and Anatomy, Atlantic City, N. J., June, 1907.

The Acid Control of the Pylorus. Am. J. Physiol., 1907–08, XX, 283–322.

1908

Some Observations on the Neuro-Muscular Mechanism of the Alimentary Canal. Proc. Am. Physiol. Soc., 1908, XXI, xx.

The Movements of the Alimentary Canal in the Dog-fish. The American Naturalist, 1908, XLII, 326.

The Opposition to Medical Research. J. A. M. A., 1908, LI, 635–646.

Chairman's Address at the Fifty-ninth Annual Meeting of the American Medical Association, in the Section on Pathology and Physiology, Chicago, Ill., June, 1908.

The Acid Closure of the Cardia. Am. J. Physiol., 1908–09, XXIII, 105–114.

Some Practical Applications of Recent Studies in the Physiology of the Digestive System. Wisconsin M. J., 1908, VII, 223–242.

Annual Address in Medicine delivered at the Sixty-second Annual Meeting of the State Medical Society of Wisconsin, Milwaukee, Wis., June, 1908.

Further Observations on the Myenteric Reflex. Proc. Am. Physiol. Soc., 1908–09, XXIII, xxvi.

1909

Interview in Boston Herald, February 28, 1909.

The Influence of Emotional States on the Functions of the Alimentary Canal. Am. J. M. Sc., 1909, CXXXVII, 480–487.

The Responsibility of the General Practitioner for Freedom of Medical Research. Boston M. & S. J., 1909, CLXI, 428–432.

Read at the Annual Meeting of the Massachusetts Medical Society, June, 1909.

Some Conditions Affecting the Discharge of Food from the Stomach. Carl A. Hedblom and Walter B. Cannon, M.D. Am. J. M. Sc., 1909, CXXXVIII, 504–521.

The Physiological Aspects of Gastro-Enterostomy. Boston M. & S. J., 1909, CLXI, 720–722.

Read at the Twelfth Annual Meeting of the American Gastro-Enterological Association, Atlantic City, N. J., June, 1909.

An Antivivisection Exhibition. Editorial, J. A. M. A., 1909, LIII, 2102–2103.

1910

The Defense of Medical Research. Editorial, J. A. M. A., 1910, LIV, 53–54.

The Correlation of the Digestive Functions. Boston M. & S. J., 1910, CLXII, 97–101.

Read at a meeting of the Medical Section of the Boston Medical Library in conjunction with the Suffolk District Medical Society, November, 1909.

An Antivivisection Leader. Editorial, J. A. M. A., 1910, LIV, 540.

The Antivivisection Agitation in New York. Editorial, J. A. M. A., 1910, LIV, 1062–1063.

Medical Control of Vivisection. North American Review, June, 1910.

Issued by the Council on Defense of Medical Research of the American Medical Association.

Also, Defense of Research Pamphlet XVI, 1910, 8 pp.

A Laboratory Course in Physiology. Harvard University Press, Cambridge, Mass., 1910, 146 pp.

1911

Some Characteristics of Antivivisection Literature. Defense of Research Pamphlet XIX, 1911, 14 pp.

Issued by the Council on Defense of Medical Research of the American Medical Association.

Also, Med.-Pharm. Critic, 1911, XIV, 59–68.

The Stimulation of Adrenal Secretion by Emotional Excitement. W. B. Cannon, M.D. and D. de la Paz, M.D. J. A. M. A., 1911, LVI, 742.

Emotional Stimulation of Adrenal Secretion. W. B. Cannon and D. de la Paz. Am. J. Physiol., 1911, XXVIII, 64–70.

The Stimulation of Adrenal Secretion by Emotional Excitement. Proc. Am. Philosoph. Soc., 1911, I, 226–227.

Read before the Society, April, 1911.

The Career of the Investigator. Science, 1911, XXXIV, 65–72.

Address to the Graduating Class, Yale Medical School, New Haven, Conn., June, 1911.

Factors Involved in the Production of Arterial Blood Pressure, Physiological and Pathological. Boston M. & S. J., 1911, CLXV, 672–675.

Read at the Annual Meeting of the Massachusetts Medical Society, June, 1911.

The Mechanical Factors of Digestion. Edward Arnold, London, England. 227 pp.

A Laboratory Course in Physiology. 2d Edition. Harvard University Press, Cambridge, Mass., 1911, 139 pp.

The Importance of Tonus for the Movements of the Alimentary Canal. Arch. Int. Med., 1911, VIII, 417–426.

Presidential Address delivered at the Fourteenth Annual Meeting of the American Gastro-enterological Association, Philadelphia, Pa., April, 1911.

The Relation of Tonus to Antiperistalsis in the Colon. Am. J. Physiol., 1911–12, XXIX, 238–249.

The Nature of Gastric Peristalsis. Am. J. Physiol., 1911–12, XXIX, 250–266.

A preliminary account of this investigation was presented at the Twenty-third Annual Meeting of the American Physiological Society, New Haven, Conn., December, 1910. See, Proceedings, This Journal, 1910–11, XXVII, xii.

The Receptive Relaxation of the Stomach. W. B. Cannon and C. W. Lieb. Am. J. Physiol., 1911–12, XXIX, 267–273.

The results of this investigation were presented at the Twenty-third Annual Meeting of the American Physiological Society, New Haven, Conn., December, 1910. See, Proceedings, This Journal, 1910–11, XXVII, xiii.

The Effects of Asphyxia, Hyperpnoea, and Sensory Stimulation on Adrenal Secretion. W. B. Cannon and R. G. Hoskins. Am. J. Physiol., 1911–12, XXIX, 274–279.

Emotional Glycosuria. W. B. Cannon, A. T. Shohl, and W. S. Wright. Am. J. Physiol., 1911–12, XXIX, 280–287.

Henry Pickering Bowditch. Proc. Am. Acad. of Arts and Sciences, 1911, XLVI, 1–9.

The Effect of Splanchnic Stimulation on Muscular Fatigue. W. B. Cannon and L. B. Nice. Proc. Am. Physiol. Soc., 1911–12, XXIX, xxiv.

1912

An Explanation of Hunger. W. B. Cannon and A. L. Washburn. Am. J. Physiol., 1911–12, XXIX, 441–454.

The indicative evidence of the results here reported was presented to the Boston Society of Medical Sciences, January, 1911.

A Note on the Effect of Nicotine Injection on Adrenal Secretion. W. B. Cannon, J. C. Aub, and C. A. L. Binger. J. Pharmacol. and Exper. Therap., 1912, III, 379–385.

Peristalsis, Segmentation, and Myenteric Reflex. Am. J. Physiol., 1912, XXX, 114–128.

The Report of the Royal Commission on Vivisection. Editorial, J. A. M. A., 1912, LVIII, 1199–1200.

Animal Experimentation and Its Benefits to Mankind. Defense of Research Pamphlet XXIII, 1912, 24 pp.

Issued by the Bureau on Protection of Medical Research of the Council on Health and Public Instruction of the American Medical Association.

Also, J. A. M. A., 1912, LVIII, 1829–1837.

Preliminary Report of the Commission on Resuscitation from Electric Shock. Dr. W. B. Cannon, Chairman. Electrical World, June 22, 1912, 134–135.

Some Unsolved Problems of Gastro-enterology. Boston M. & S. J., 1912, CLXVII, 181–183.

Presidential Address delivered at the Fifteenth Annual Meeting of the American Gastro-enterological Association, Atlantic City, N. J., June, 1912.

A Consideration of the Nature of Hunger. The Popular Science Monthly, 1912, LXXXI, 291–307.

Read before the Harvey Society, New York, December, 1911.

Animal Experimentation. Woods Reference Handbook of Medical Sciences, 4th Edition, 1912, I, 440–448.

The Functions of the Large Intestine. J. A. M. A., 1912, LIX, 1–4.

Read at the Sixty-third Annual Meeting of the American Medical Association, in the section on Surgery, Atlantic City, N. J., June 1912.

1913

A New Colorimetric Method for the Determination of Epinephrine. O. Folin, W. B. Cannon, and W. Denis. J. Biol. Chem., 1913, XIII, 477–483.

The Depressor Effect of Adrenalin on Arterial Pressure. W. B. Cannon and H. Lyman. Am. J. Physiol., 1912–13, XXXI, 376–398.

The Effect of Adrenal Secretion on Muscular Fatigue. W. B. Cannon and L. B. Nice. Am. J. Physiol., 1913, XXXII, 44–60.

A preliminary report of this research was presented at the Twenty-fourth Annual Meeting of the American Physiological Society, Baltimore, Md., December, 1911. See, Proceedings, This Journal, 1911–12, XXIX, xxiv.

Recent Antivivisection Activity. Editorial, J. A. M. A., 1913, LXI, 282.

Report of the Commission on Resuscitation from Electric Shock. Dr. W. B. Cannon, Chairman. National Electric Light Association, New York, N. Y., 1913, 23 pp.

Read before the National Electric Light Association at its Thirty-sixth Annual Convention, Chicago, Ill., June, 1913.

The Endurance of Anemia by Nerve Cells in the Myenteric Plexus. W. B. Cannon and I. R. Burket. Am. J. Physiol., 1913, XXXII, 347–357.

The Washington Antivivisection Congress. Editorial, J. A. M. A., 1913, LXI, 2244–2245.

Antivivisection Legislation: Its History, Aims, and Menace. Defense of Research Pamphlet XXV, 1913, 11 pp.

Issued by the Bureau on Protection of Medical Research of the Council on Health and Public Instruction of the American Medical Association.

Also, J. A. M. A., 1913, LX, 1511–1514.

A Laboratory Course in Physiology. 3d Edition. Harvard University Press, Cambridge, Mass., 1913, 151 pp.

1914

Early Use of the Roentgen Ray in the Study of the Alimentary Canal. J. A. M. A., 1914, LXII, 1–3.

Read at the Fourteenth Annual Meeting of the American Roentgen Ray Society, Boston, Mass., October, 1913.

The Emergency Function of the Adrenal Medulla in Pain and the Major Emotions. Am. J. Physiol., 1914, XXXIII, 356–372.

Medical Support of the Antivivisectionists. Editorial, J. A. M. A., 1914, LXII, 541–542.

Recent Studies of Bodily Effects of Fear, Rage, and Pain. J. Philos., Psychol., and Sci. Meth. 1914, XI, 162–165.

More about Vivisection. Letter to the Boston Herald, March 12, 1914.

Testimony on Vivisection. Letter to the Boston Herald, March 28, 1914.

Another Antivivisection Fiasco. Editorial, J. A. M. A., 1914, LXII, 1025.

The Interrelations of Emotions as Suggested by Recent Physiological Researches. Am. J. Psychol., 1914, XXV, 256–282.

Factors Affecting the Coagulation Time of Blood. Am. J. Physiol., 1914, XXXIV, 225–261.

I. The Graphic Method of Recording Coagulation Used in these Experiments. W. B. Cannon and W. L. Mendenhall. Am. J. Physiol., 1914, XXXIV, 225–231.

A preliminary report of these experiments was presented at the Twenty-sixth Annual Meeting of the American Physiological Society, Philadelphia, Pa., December, 1913. See, Proceedings, This Journal, 1914, XXXIII, xxxviii; also 372.

II. The Hastening or Retarding of Coagulation by Adrenalin Injections. W. B. Cannon and H. Gray. Am. J. Physiol., 1914, XXXIV, 232–242.

III. The Hastening of Coagulation by Stimulating the Splanchnic Nerves. W. B. Cannon and W. L. Mendenhall. Am. J. Physiol., 1914, XXXIV, 243–250.

IV. The Hastening of Coagulation in Pain and Emotional Excitement. W. B. Cannon and W. L. Mendenhall. Am. J. Physiol., 1914, XXXIV, 251–261.

The Utility of Bodily Changes in Fear, Rage, and Pain. Harvard Graduates Magazine, 1913–14, XXII, 570–573.

Report of the Committee on Resuscitation from Mine Gases. W. B. Cannon, Chairman. Technical Paper 77, Department of the Interior, Bureau of Mines, 1914, 33 pp.

Some Characteristics of Antivivisection Literature. Scient. Am. Suppl., 1914, LXXVIII, 58.

The Physiologic Equivalent of War: Wesley M. Carpenter Lecture. J. A. M. A., 1914, LXIII, 1415.

Methods of Resuscitation. Science, 1914, XL, 663.

1915

Experimental Hyperthyroidism. W. B. Cannon, C. A. L. Binger, and R. Fitz. Am. J. Physiol., 1914–15, XXXVI, 363–364.

An Antivivisection Inquiry. Editorial, J. A. M. A., 1915, LXIV, 1505.

Antivivisection in California. Editorial, J. A. M. A., 1915, LXV, 258.

The Suspicions of Antivivisectionists. Editorial, J. A. M. A., 1915, LXV, 536.

Bodily Changes in Pain, Hunger, Fear, and Rage. D. Appleton & Co., New York and London, 1915, 324 pp.

Translated into Russian as "Physiology of Emotions," Priboi, Leningrad, 1927.

Translated into Chinese, The Commercial Press, Ltd., Shanghai, 1928, 234 pp.

Results of Overactivity of the Cervical Sympathetic. W. B. Cannon and R. Fitz. Tr. Ass. Am. Physicians, 1915, XXX, 302–304.

1916

Further Observations on Overactivity of the Cervical Sympathetic. W. B. Cannon and R. Fitz. Am. J. Physiol., 1916, XL, 126.

The Emotions and Digestion. The Youth's Companion, May 4, 1916, 239.

Studies of Ductless Glands by the Electrical Method. Proc. Nat. Acad. Sci., 1916, II, 319.

Read before the Academy, April, 1916.

Studies on the Conditions of Activity in Endocrine Glands. W. B. Cannon and McK. Cattell. Am. J. Physiol., 1916, XLI, 39–78.

I. The Electrical Response as an Index of Glandular Action. Am. J. Physiol., 1916, XLI, 39–57.

II. The Secretory Innervation of the Thyroid Gland. Am. J. Physiol., 1916, XLI, 58–73.

III. The Influence of the Adrenal Secretion on the Thyroid. Am. J. Physiol., 1916, XLI, 74–78.

The main results of these three papers were presented at the Twenty-eighth Annual Meeting of the American Physiological Society, Boston, Mass., December, 1915. See, Proceedings, This Journal, 1916, XL, 143.

Metchnikoff. The New Republic, August 12, 1916, 37–39.

Some Conditions Controlling Thyroid Activity. W. B. Cannon and McK. Cattell. Boston M. & S. J., 1916, CLXXIV, 138.

Conditions Affecting Secretion of the Thyroid Gland. Boston M. & S. J., 1916, CLXXV, 562–563.

Read at a joint meeting of the Sections of Medicine and of Surgery, Massachusetts Medical Society, June, 1916.

Also, Tr. Ass. Am. Physicians, 1916, XXXI, 162–164.

The Right and Wrong of Making Experiments on Human Beings. Editorial, J. A. M. A., 1916, LXVII, 1372.

Some Disorders Supposed to Have an Emotional Origin. Abstr., New York M. J., 1916, CIV, 870–873.

Read at a meeting of the New York Academy of Medicine, May, 1916.

Results of Recent Studies on Ductless Glands. J. A. M. A., 1916, LXVII, 1483–1485.

Read at the Sixty-seventh Annual Meeting of the American Medical Association, in the Section on Pathology and Physiology, Detroit, Mich., June, 1916.

Some Relations Between Emotions and Glands of Internal Secretion. Journal-Lancet, 1916, XXXVI, 685–688.

Oscillatory Variations in the Contractions of Rhythmically Stimulated Muscle. W. B. Cannon and C. M. Gruber. Am. J. Physiol., 1916–17, XLII, 36–45.

A New Concept of Diseases Having Emotional Elements. Vermont Med., 1916, I, 61–66.

Oration in Medicine, delivered before the Vermont State Medical Society, Burlington, Vt., October, 1915.

1917

Medical Research in its Relation to Medical Schools. F. S. Lee, W. B. Cannon, and R. M. Pearce. Report of the Committee on Medical Research. Proc. of the Twenty-seventh Annual Meeting, Assoc. Am. Med. Coll., Chicago, Ill., February, 1917, 19–31.

Also, J. A. M. A., 1917, LXVIII, 1075–1079.

Modern Explanations of Giants and Dwarfs. The Youth's Companion, April 26, 1917, 235.

A Note on the Effect of Asphyxia and Afferent Stimulation on Adrenal Secretion. Science, 1917, n.s., XLV, 463.

The Physiological Factors Concerned in Surgical Shock: The Shattuck Lecture. Boston M. & S. J., 1917, CLXXVI, 859–867.

Read before the Massachusetts Medical Society, June, 1917.

Traumatic Shock and Gas Infection and Effects of Treatment. Mil. Surgeon 1917, XLI, 774–778.

The Response of the Pyloric Mechanism. Letter. J. A. M. A., 1917, LXVIII, 390.

Reports of the Special Investigation Committee on Surgical Shock and Allied Conditions.

No. 2. Investigation of the Nature and Treatment of Wound Shock and Allied Conditions. Medical Research Committee, London, England, 1917, 93 pp.

II. Some Alterations in the Distribution and Character of the Blood. Captain W. B. Cannon, Captain John Fraser, and Captain A. N. Hooper. 27–40.
Also, J. A. M. A., 1918, LXX, 526–531.

III. Acidosis in Cases of Shock, Haemorrhage, and Gas Infection. 41–57.
Also, J. A. M. A., 1918, LXX, 531–535.

V. A Consideration of the Nature of Wound Shock. 67–83.
Also, J. A. M. A., 1918, LXX, 611–617.

VI. The Preventive Treatment of Wound Shock. Captain W. B. Cannon, Captain John Fraser, and Captain E. M. Colwell. 84–93.
Also, J. A. M. A., 1918, LXX, 618–621.

1918

The Physiological Basis of Thirst: Croonian Lecture, June, 1918. Proc. Roy. Soc., London, 1917–19, S. B., XC, 283–301.

Translated into French: Les bases physiologiques de la soif. Rev. gén. d. sc. pures et appliq., 1919, XXX, 69–79.

Letters from Professor W. B. Cannon, '96. Harvard Alumni Bulletin, 1918, XX, 664.

L'Etat de shock. Le Progrès Médical, 1918, XXXII, 290.

Le choc. Le Progrès Médical, 1918, XXXII, 368.

Traumatic Shock. Abstr., War Med., 1918–19, II, 1367–1370.
Presented before the Société de Biologie, Paris, October, 1918.

Traumatic Shock and Hemorrhage. Medical Publication Bureau of the American Red Cross Society in France, 29 pp.

Reports of the Special Investigation Committee on Surgical Shock and Allied Conditions.

No. 7. Acidosis and Shock. Medical Research Committee, London, England, 1918, 42 pp.

A Basis for Discussion of Traumatic Shock. Compt. rend. Soc. de biol., 1918, LXXXI, 850–853.

Translated into French. Compt. rend. Soc. de biol., 1918, LXXXI, 854–863.

Shock and its Control. Am. J. Physiol., 1917–18, XLV, 544.

Acidosis in Shock. Med. Bull., 1917–18, I, 424–428.
Presented at the Fourth Session of the Research Society of the American Red Cross in France, Paris, March, 1918.

1919

Reports of the Special Investigation Committee on Surgical Shock and Allied Conditions.
No. 8. Traumatic Toxaemia as a Factor in Shock. Medical Research Committee, London, England, 1919, 47 pp.
IV. Note on Muscle Injury in Relation to Shock. W. B. Cannon and W. M. Bayliss. 1919, 19–23.
VI. Some Characteristics of Shock Induced by Tissue Injury, 1919, 27–32.

Wound Shock. Mil. Surgeon, 1919, XLIV, 494–506.
A lecture to officers of the Army Sanitary School at Langres, France, November, 1918.

The Course of Events in Secondary Wound Shock. J. A. M. A., 1919, LXXIII, 174–181.
Read at the Seventieth Annual Meeting of the American Medical Association, in the Section on Surgery, General and Abdominal, Atlantic City, N. J., June, 1919.

The Production of Shock. Letter, J. A. M. A., 1919, LXXIII, 439.

Effects of Ether and Nitrous Oxid-Oxygen Anesthesia in Cases of Shock and Hemorrhage. J. A. M. A., 1919, LXXIII, 444.
Read at a Symposium on Anesthesia for War Surgery at the Seventh Annual Meeting of the American Association of Anesthetists, Atlantic City, N. J., June, 1919.

Sur le shock traumatique. W. B. Cannon, G. W. Crile, et al. Arch. de méd. et pharm. mil., 1919, LXXI, 341–349.

Sur l'Anesthésie au protoxyde d'azote. Arch. de méd. et pharm. mil., 1919, LXXI, 276.

Studies on the Conditions of Activity in Endocrine Glands.
V. The Isolated Heart as an Indicator of Adrenal Secretion Induced by Pain, Asphyxia and Excitement. Am. J. Physiol., 1919–20, L, 399–432.

1920

Some Conditions Affecting Thyroid Activity. With P. E. Smith. Proc. Soc. Exper. Biol. and Med., 1919–20, XVII, 88–89.
Also, Abstr. Endocrinology, 1920, IV, 386.
Read before a meeting of the Association for the Study of Internal Secretions, New Orleans, La., April, 1920.

1921

The Argument for Vivisection. Letter to the Boston Herald, March 1, 1921.

The Endocrine Glands — A Caution. Editorial, J. A. M. A., 1921, LXXVI,1500–1501.

A Layman's Defense of Animal Experimentation. Editorial, J. A. M. A., 1921, LXXVII, 469.

Medical Support for the Antivisectionists. Editorial, J. A. M. A., 1921, LXXVII, 559.

Pawlow is Still Alive. Letter, J. A. M. A., 1921, LXXVII, 1040.

Studies on the Conditions of Activity in Endocrine Glands. Am. J. Physiol., 1921–22, LVIII, 308–364.

VI. Further Observations on the Denervated Heart in Relation to Adrenal Secretion. W. B. Cannon and D. Rapport. Am. J. Physiol., 1921–22, LVIII, 308–337.

VII. The Reflex Center for Adrenal Secretion and Its Response to Excitatory and Inhibitory Influences. W. B. Cannon and D. Rapport. Am. J. Physiol., 1921–22, LVIII, 338–352.

VIII. Some Effects on the Denervated Heart of Stimulating the Nerves of the Liver. W. B. Cannon and J. E. Uridil. Am. J. Physiol., 1921–22, LVIII, 353–364.

Traumatic Shock. Keen's Surgery, 1921, VII, 296–315.

Some New Evidence Regarding the Control of the Thyroid Gland. Trans. New Hampshire Med. Soc., 1921, CXXX, 144–151.

Presented at the One Hundred and Thirtieth Anniversary of the New Hampshire Medical Society, Concord, N. H., May, 1921.

Evidence of Nervous Control of Some Internal Secretions. J. Nerv. and Ment. Dis., 1921, LIV, 421–433.

Read by invitation before the New York Neurological Society, October, 1921.

Some Novel Effects Produced by Stimulating the Nerves of the Liver. With J. E. Uridil and F. R. Griffith. Abstr., Tr. Ass. Am. Physicians, 1921, XXXVI, 380–381.

Also, Endocrinology, 1921, V, 729–730.

New Evidence of Thyroid Secretion Following Stimulation of the Cervical Sympathetic. W. B. Cannon and P. E. Smith. Abstr., Tr. Ass. Am. Physicians 1921, XXXVI, 382.

Movements of the Intestines Studied by Means of Roentgen Rays. J. Radiol., 1921, II, No. 4, 28–36.

1922

Studies in Experimental Traumatic Shock. Arch. Surg., 1922, IV, 1–22 and 300–323.

IV. Evidence of a Toxic Factor in Wound Shock. Arch. Surg., 1922, IV, 1–22.

V. The Critical Level in a Falling Blood Pressure. W. B. Cannon and McK. Cattell. Arch. Surg., 1922, IV, 300–323.

Studies on the Conditions of Activity in Endocrine Glands. Am. J. Physiol., 1922, LX, 476–495 and 544–559.

IX. Further Evidence of Nervous Control of Thyroid Secretion. W. B. Cannon and P. E. Smith. Am. J. Physiol., 1922, LX, 476–495.

The results here reported were presented at the One Hundred and First Annual Meeting of the Society for Experimental Biology and Medicine, New York, February, 1920. See, Proc. Soc. Exper. Biol. and Med., 1920, XVII, 88.

X. The Cardio-Accelerator Substance Produced by Hepatic Stimulation. W. B. Cannon and F. R. Griffith. Am. J. Physiol., 1922, LX, 544–559.

Invitations to Research in Endocrinology. Endocrinology, 1922, VI, 745–759.

Address as President of the Association for the Study of Internal Secretions, June, 1922.

The Antivivisection Initiative in Colorado. Editorial, J.A.M.A., 1922, LXXVIII, 1895.

The Heritage of Life. Pamphlet V, Positive Health Series, Women's Foundation for Health, Inc., New York City, 1922, 11 pp.

Some Conditions Controlling Internal Secretion. J. A. M. A., 1922, LXXIX, 92–95.

Read at the Seventy-third Annual Meeting of the American Medical Association, in the joint meeting of the Section on Practice of Medicine, the Section on Pharmacology and Therapeutics, and the Section on Pathology and Physiology, St. Louis, Mo., May, 1922.

Algunas Condiciones que Gobiernan la Secrecion Interna. J. A. M. A., E. E., 1922, VIII, 69–73.

The "Open Door" Policy in Animal Experimentation. Editorial, J. A. M. A., 1922, LXXVIII, 1820.

What Strong Emotions Do to Us. Harper's Magazine, July, 1922, 234–241.

Studies on the Conditions of Activity in Endocrine Glands. XI. Further Evidence for Reflex and Asphyxial Secretion of Adrenin. W. B. Cannon and R. Carrasco Formiguera. Am. J. Physiol., 1922, LXI, 215–227.

New Evidence for Sympathetic Control of Some Internal Secretions. Am. J. Psychiat., 1922–1923, II, 15–30.

Address before the American Psychiatric Association at its Seventy-eighth Annual Meeting, Quebec, P. Q., June, 1922.

A Critical Consideration of Endocrine Therapy. Boston M. & S. J., 1922, CLXXXVII, 163–164.

Read before the Suffolk District Medical Society, April, 1922.

Nervous Control of the Thyroid Gland. Northwest Med., 1922, XXI, 289–294.

Read before the First Session of the Pacific Northwest Medical Association, July, 1922.

The Recent Evidence as to the Nature of Wound Shock. Northwest Med., 1922, XXI, 351–355.

Read before the First Session of the Pacific Northwest Medical Association, July, 1922.

Antivivisection Propaganda by Camouflage. Editorial, J. A. M. A., 1922, LXXIX, 1337.

Some Problems of Readjustment in Medical Practice. Boston M. & S. J., 1922, CLXXXVII, 715–721.

Address to the graduating class of the Women's Medical College of Pennsylvania, Philadelphia, Pa., June, 1921.

The Emergency Function of the Suprarenal Medulla. From "Endocrinology and Metabolism." Edited by Barker, Hoskins and Mosenthal. D. Appleton & Co., New York and London, 1922, II, 171–185.

Some New Observations Regarding Control of the Thyroid Gland. Abstr., Surg. Gynec. Obst., 1922, XXXV, 244–246.

Presented at a meeting of the Chicago Surgical Society, Chicago, Ill., March, 1922.

1923

The Value of Animal Experimentation to the Physician in His Daily Work. Boston M. & S. J., 1923, CLXXXVIII, 30–32.

A fifteen minute address at a public meeting at Ford Hall, Boston, November, 1922.

Carbon Monoxide Asphyxia: The Problem of Resuscitation. Report II of the Commission on Resuscitation from Carbon

Monoxide Asphyxia. Cecil K. Drinker and Walter B. Cannon. J. Indust. Hyg., 1922–23, IV, 463–473.

The Control of Bodily Processes by Glands. Hygeia, 1923, I, 11–17.

The Effect of the Blood-Sugar Level on Adrenal Secretion and Sympathetic Activity; A Preliminary Note. W. B. Cannon, M. McIver, and S. W. Bliss, Boston M. & S. J., 1923, CLXXXIX, 141.

Impounded Animals for the Service of Medicine. Editorial, J. A. M. A., 1923, LXXXI, 1611.

"Friends of Medical Progress." Editorial, J. A. M. A., 1923, LXXXI, 1443–1444.

Traumatic Shock. D. Appleton & Co., New York and London, 1923, 201 pp.

A Laboratory Course in Physiology. 4th Edition. Harvard University Press, Cambridge, Mass., 1923, 157 pp.

1924

Biographical Memoir — Henry Pickering Bowditch, 1840–1911. Memoirs Nat. Acad. Sci., 1924, XVII, 183–196.
Presented at the Annual Meeting of the Academy, 1922.

The Rôle of Adrenal Secretion in the Chemical Control of Body Temperature. W. B. Cannon and A. Querido. Proc. Nat. Acad. Sci., 1924, X, 245–246.
Read before the Academy, April, 1924.

Increase of Adrenal Secretion in Fever. W. B. Cannon and J. R. Pereira. Proc. Nat. Acad. Sci., 1924, X, 247–248.

Studies on the Conditions of Activity in Endocrine Glands. Am. J. Physiol., 1924, LXIX, 46-66, and LXXI, 153–162.

XIII. A Sympathetic and Adrenal Mechanism for Mobilizing Sugar in Hypoglycemia. W. B. Cannon, M. A. McIver and S. W. Bliss. Am. J. Physiol., 1924, LXIX, 46-66.

XIV. The Effects of Muscle Metabolites on Adrenal Secretion. W. B. Cannon, J. R. Linton, and R. R. Linton. Am. J. Physiol., 1924–25, LXXI, 153–162.

An Endocrine Factor in the Chemical Control of Body Temperature. Tr. Ass. Am. Physicians, 1924, XXXIX, 162–166.

1925

Man's Debt to the Animals. Columbia, March, 1925, 22.

Studies on the Conditions of Activity in Endocrine Glands. Am. J. Physiol., 1925, LXXII, 283–313.

XV. Pseudaffective Medulliadrenal Secretion. W. B. Can-

non and S. W. Britton. Am. J. Physiol., 1925, LXXII, 283–294.

XVI. The Rôle of the Adrenal Medulla in Pseudaffective Hyperglycemia. E. Bulatoa and W. B. Cannon. Am. J. Physiol., 1925, LXXII, 295–313.

Why I Believe in Evolution. The Liberal Christian, 1925, III, 5.

Some Recent Revelations by the Denervated Heart. Proc. Inter-State Post-Grad. Med. Assemb. North America, St. Paul, Wis., 1925, I, 242–245.

1926

Some General Features of Endocrine Influence on Metabolism. Am. J. M. Sc., 1926, CLXXI, 1–20.

Read at a Symposium on Internal Secretion, Congress of American Physicians, New Haven, Conn., May, 1925.

Also Trans. Cong. Am. Phys. and Surg., 1925, XIII, 31–53.

The Dog's Gift to the Relief of Human Suffering. Hygeia, 1926, IV, 3–6.

Report of the Committee for the Protection of Medical Research. W. B. Cannon, Chairman. J. A. M. A., 1926, LXXXVI, 862–863.

A Laboratory Course in Physiology. 5th Edition. Harvard University Press, Cambridge, Mass., 1926, 157 pp.

Hypoglycemia and Convulsions. Editorial, J. A. M. A., 1926, LXXXVI, 1351–1352.

Physiological Regulation of Normal States: Some Tentative Postulates Concerning Biological Homeostatics. A Contribution to the Jubilee Volume to Charles Richet, May 22, 1926, 91–93.

Studies on the Conditions of Activity in Endocrine Glands. XVII. A Lasting Preparation of the Denervated Heart for Detecting Internal Secretion, with Evidence for Accessory Accelerator Fibers from the Thoracic Sympathetic Chain. W. B. Cannon, J. T. Lewis, and S. W. Britton with the co-operation of J. R. Pereira, A. Groeneveld, J. R. Linton and R. R. Linton. Am. J. Physiol., 1926, LXXVII, 326–352.

Muscular Rigidity With and Without Sympathetic Innervation. A. Forbes, W. B. Cannon, J. O'Connor, A. McH. Hopkins, and R. H. Miller. Arch. Surg., 1926, XIII, 303–328.

Emotional Stimulation of Medulliadrenal Secretion. With S. W. Britton. Science, 1926, LXIII, 529–530.

Presented at the Annual Meeting of the National Academy of Sciences, Washington, D. C., 1926.

1927

Studies on the Conditions of Activity in Endocrine Glands. Am. J. Physiol., 1926–27, LXXIX, 433–507.

XX. The Influence of Motion and Emotion on Medulliadrenal Secretion. W. B. Cannon and S. W. Britton with the collaboration of J. T. Lewis and A. Groeneveld. Am. J. Physiol., 1926–27, LXXIX, 433–465.

XXI. The Rôle of Adrenal Secretion in the Chemical Control of Body Temperature. W. B. Cannon, A. Querido, S. W. Britton, and E. M. Bright. Am. J. Physiol., 1926–27, LXXIX, 466–507.

The History of the Physiology Department of the Harvard Medical School. Harvard Medical Alumni Bulletin, 1927, I, 12–19.

An informal talk in the H. P. Bowditch Library of Physiology and Biochemistry, Harvard Medical School.

The "Physiological Maximum Heart Rate" as an Artefact. W. B. Cannon and J. T. Lewis. Am. J. Physiol., 1927, LXXXII, 67–74.

Wound Shock. The Medical Department of the United States Army in the World War, 1927, XI, 185–213.

A Laboratory Course in Physiology. 7th Edition. Harvard University Press, Cambridge, Mass., 1927, 159 pp.

Translated into Spanish by F. F. Izquierdo.

"Oscillatory Variations in the Contractions of Rhythmically Stimulated Muscle"—A Correction and a Warning. W. B. Cannon and J. R. Pereira. Am. J. Physiol., 1927, LXXXII, 63–66.

The Dispensability of the Sympathetic Division of the Autonomic Nervous System. W. B. Cannon, J. T. Lewis, and S. W. Britton. Boston M. & S. J., 1927–28, CXCVII, 514–515.

Letter on the above. Boston M. & S. J., 1927, CXCVII, 1249.

The James-Lange Theory of Emotions: A Critical Examination and an Alternative Theory. Am. J. Psychol., Washburn Commemorative Volume, 1927, XXXIX, 106–124.

Neural Organization for Emotional Expression. Edited by Carl Murchison. Chapter 22, Feelings and Emotions, 257–269, Clark University Press, Worcester, Mass.

1928

Studies on the Conditions of Activity in Endocrine Glands. XXIII. Emotional Polycythemia in Relation to Sympathetic and Medulliadrenal Action on the Spleen. J. J. Izqui-

erdo and W. B. Cannon. Am. J. Physiol., 1928, LXXXIV, 545–562.

The Mechanism of Emotional Disturbance of Bodily Functions. New England J. Med., 1928, CXCVIII, 877–884.

The Annual Discourse delivered before the Massachusetts Medical Society, Worcester, Mass., June, 1928.

William Einthoven, 1860–1927. Proc. Am. Acad. of Arts and Sciences, 1928, LXII, 253–254.

Die Notfallsfunktionen des sympathico-adrenalen Systems. (Deutsche Ubertragung von Frau Else Asher). Sonderdruck aus Ergebnisse der Physiologie, herausgegeben von L. Asher und K. Spiro, XXVII, 380–406. Verlag von F. Bergmann, München, 1928.

Reasons for Optimism in the Care of the Sick. New England J. Med., 1928, CXCIX, 593–597.

Annual Oration, delivered before the Middlesex South District Medical Society, April, 1928.

Lectures on Conditioned Reflexes. By Ivan P. Pavlov. Introduction by W. B. Cannon. Twenty-five Years of Objective Study of the Higher Nervous Activity (Behavior) of Animals. Translated from the Russian by W. Horsley Gantt, 1928, International Publishers Co., New York.

1929

Some Conditions Affecting the Capacity for Prolonged Muscular Work. F. A. de M. Campos, W. B. Cannon, H. Lundin and T. T. Walker, with the assistance of J. H. Walker. Am. J. Physiol., 1928–29, LXXXVII, 680–701.

Some Aspects of the Physiology of Animals Surviving Complete Exclusion of Sympathetic Nerve Impulses. W. B. Cannon, H. F. Newton, E. M. Bright, V. Menkin, and R. M. Moore. Am. J. Physiol., 1929, LXXXIX, 84–107.

Bodily Changes in Pain, Hunger, Fear and Rage. 2d Edition. D. Appleton & Co., New York and London, 1929, 404 pp.

Organization for Physiological Homeostasis. Physiol. Rev., 1929, IX, 399–427.

Functions of the Sympathetic System in Maintaining the Stability of the Organism. Proc. Instit. Med. of Chicago, 1929, VII, 229–231.

Read at a Joint Meeting of the Institute of Medicine and the Chicago Society for Internal Medicine, October, 1929.

Sympathetic Division of the Autonomic System in Relation to Homeostasis. Arch. Neurol. and Psychiat., 1929, XXII, 282–294.

Read at the Ninth Annual Meeting of the Association for Research in Mental and Nervous Diseases, New York City, December, 1928.

Hunger and Thirst. Edited by Carl Murchison. Chapter XI, The Foundations of Experimental Psychology, 1929, 434–448. Clark University Press, Worcester, Mass.

The Control of Homeostasis by the Sympathetic System. Tr. Ass. Am. Physicians, 1929, XLIV, 41–51.

Frederick Cheever Shattuck. W. B. Cannon, H. A. Christian, and R. P. Strong. Science, 1929, LXIX, 207–208.

Pharmacological Injections and Physiological Inferences. Science, 1929, LXX, 500–501.

Emergency Function of Spleen. 1928 Proc. Inter-State Post-Grad. Med. Assemb. North America, Atlanta, Ga., 285–288.

Report of Committee on Pernicious Anemia of the Harvard Medical School. W. B. Cannon, Chairman. J. A. M. A., 1929, XCIII, 1144–1145.

1930

The Integrative Action of the Vascular System. Chapter X, Cowdry's "Human Biology and Racial Welfare," 219–245. Paul B. Hoeber Co., New York.

Endocrinology by Ukase. Endokrinologie, 1930, VI, 24–27.

Physiologie: Le système sympathique comme agent de la stabilité de l'organisme. Compt. rend. Acad. d. sc., 1930. CXC, 446–447.

The Autonomic Nervous System: An Interpretation. The Linacre Lecture. Lancet, 1930, I, 1109–1115.

The Heart Rate of Unanesthetized Normal, Vagotomized, and Sympathectomized Cats as Affected by Atropine and Ergotoxine. Robert M. Moore and W. B. Cannon. Am. J. Physiol., 1930, XCIV, 201–208.

Le rôle du système sympathico-surrénal au point de vue du maintien de la stabilité organique (Homéostasie). Revue Belge des Sciences Médicales, 1930. II, 451–464.

Conference donnée a l'Institut de Physiologie de l'Université de Louvain, March, 1930.

Quelques Observations sur le Comportement Maternel d'Animaux privés du Système Sympathique. J. de psychol. norm. et path., 1930, 486–488.

Read before the Société de Psychologie at the Sorbonne, Paris, France, February, 1930.

Troubles émotifs des fonctions de l'organisme. Montpellier méd., 1930, LII, 395–407.

1931

Studies on the Conditions of Activity in Endocrine Glands. Am. J. Physiol., 1931, XCVI, 377–412, and XCVIII, 447–452.

XXV. The Mystery of Emotional Acceleration of the Denervated Heart After Exclusion of Known Humoral Accelerators. With H. F. Newton and R. L. Zwemer. Am. J. Physiol., 1931, XCVI, 377–391.

XXVI. A Hormone Produced by Sympathetic Action on Smooth Muscle. With Z. M. Bacq. Am. J. Physiol., 1931, XCVI, 392–412.

XXVII. Evidence that Medulliadrenal Secretion is not Continuous. Am. J. Physiol., 1931, XCVIII, 447–452.

Producción de una hormona por la acción del simpático sobre el músculo liso. Día méd., 1931, III, 715.

Homeostasis of the Fluid Matrix as Affected by Exterofective and Interofective Nerve Systems. Editorial, Surg. Gynec. Obst., 1931, LII, 910–911.

A Belated Effect of Sympathectomy on Lactation. With E. M. Bright. Am. J. Physiol., 1931, XCVII, 319–321.

Again the James-Lange and the Thalamic Theories of Emotion. Psychol. Rev., 1931, XXXVIII, 281–295.

A Laboratory Course in Physiology. 8th Edition. Harvard University Press, Cambridge, Mass., 1931, 160 pp.

An Unsuccessful Attempt to Demonstrate Humorial Action of "Vagus Substance" in the Circulating Blood. N. E. Freeman, R. A. Phillips, and W. B. Cannon. Am. J. Physiol., 1931, XCVIII, 435–439.