Editor's Page

The Society wishes to thank Dr. Janet H. Clark, daughter of Dr. W. H. Howell fourth president of the Society, for sending us historical material and pictures from her father's collection. The material includes biographies of several early physiologists, a copy of the second edition of Howell's "Textbook of Physiology," and papers of H. Newell Martin, one of the founders of the American Physiological Society. The material is being catalogued and will be kept in the Society Archives.

The abstracts of papers to be presented at the Fall Meeting in Stanford, California, will be published in the August issue of THE PHYSIOLOGIST. This year abstracts will be submitted on special forms (similar but different in size from the forms used for the Federation Meeting). Abstracts will appear in the August issue as direct offsets of author copies. Forms have been mailed to members by the Local Committee. The deadline for receipt of abstracts in the Central Office (9650 Wisconsin Avenue, Washington 14, D.C.) is June 21. Extra forms can be secured from the Central Office.

FEDERATION MEETING -- CHICAGO

The official registration at the Federation Meetings was 11,020. There were 255 scientific sessions with 2654 papers. The American Physiological Society had 59 scientific sessions with 574 papers. This included a symposium; a teaching session and 57 regular sessions, 8 of which started with a thirty-minute resume of the subject.

Even though the programs were "hand made" by the Secretaries of the various Societies, the Subject Index and the arrangement of the printed abstracts were done by the UNIVAC as a part of the experiment conducted by the Federation this year. The UNIVAC also made up an integrated program for the Federation. This program, along with a UNIVAC-made Physiology program, is being evaluated by a sample of the membership. It is hoped that a comparative evaluation will be available for publication in THE PHYSIOLOGIST.

ACTIONS TAKEN AT APS BUSINESS MEETINGS

April 12 and 14, 1960

ELECTIONS. H. W. Davenport was elected to the position of President-Elect. Hermann Rahn was elected to a four-year term on Council. J. M. Brookhart was elected to fill the unexpired term of H. W. Davenport as a Councilman. All those nominated by Council were elected to membership. (See Newly Elected Members -- this issue.)

MEMBERSHIP. The Society passed the following addition to the BYLAWS relative to a new type of membership.

> ARTICLE I, SECTION 5. Sustaining Associates. Individuals and organizations who have an interest in the advancement of biological or biophysical investigation, may be invited by the President, with the approval of Council, to become sustaining associates.

It was pointed out that Sustaining Associates would have no vote, could not present papers without regular member sponsorship, etc.

FINANCES. It was announced that the Society General Fund is solvent and funds are adequate for 1960. The General Fund will have built up a savings of approximately $30,000 by July 1960 -- sufficient reserve for one year's operation; $11,000 of this reserve represents earnings on the course entitled "The Physiological Basis for Diagnosis and Treatment," sponsored by the Society in cooperation with the University of California School of Medicine, March 30 - April 3. J. H. Comroe, Jr. was Director of the course.

An estimated budget for 1961 was presented and discussed in light of loss of revenue from Education Committee grants which will be discontinued late in 1960. The estimated deficit for the year 1961 is approximately $6,000. Various means for securing funds to offset the deficit were discussed. Details of the finances and budgets, including those of the Publication Trustees, will be published in the November issue of THE PHYSIOLOGIST.

APPOINTMENTS. Council appointed the following to fill positions of those whose term of office expires July 1, 1960.

Board of Publication Trustees - H. S. Mayerson
Membership Advisory Committee - Hallowell Davis
Education Committee - W. D. Lotspeich
Porter Fellowship Committee - R. S. Alexander
Program Advisory Committee - T. C. Ruch
AAAS Representative - C. McC. Brooks
Bowditch Lecturer - The President announced that he had selected Carl W. Gottschalk to give the Bowditch Lecture at the 1960 Fall Meeting. The title of his address will be, "Micropuncture Studies of Tubular Function in the Mammalian Kidney."

Porter Fellowship. The Committee unanimously selected Mr. Edward S. Kirk for a two-year period. He will work under Dr. C. R. Honig in the Department of Physiology at the University of Rochester. It was also announced that the Harvard Apparatus Co. (donor of the funds for the Porter Fellowship) would provide expenses for the Porter Fellow to attend the Fall Meeting of the Society. The present Porter Fellow, Donald F. Laws, will be invited to attend the meeting at Stanford.

AIBS. The Society voted strongly to retain full membership in AIBS.

USE AND CARE OF ANIMALS. In regard to the impending congressional bill on the use and care of animals, the Society passed the following motion:

> "That the American Physiological Society express its disapproval of any measure which would hamper the progress of medical and biological research under the guise of promotion of humane treatment of animals, which treatment is already assured by statutes prohibiting cruelty of animals and -- Further, that it authorize a committee of the Society to express this position in appropriate ways to oppose the proposed Symington Bill."

FEDERATION. The following motion was made and passed.

> "Resolved, that the Council re-examine and place before the Society various views regarding the value to the Society of the Annual Meeting of the Federation and the relation of the Society with the Federation. Part of this study and discussion should include the financial relations of the Society and the Federation and possible alternative activities of the Society."

FUTURE MEETINGS

Spring 1961, 1962, 1963 - Atlantic City, N.J. All meetings will be held during the calendar week that contains April 15.

Spring 1964, 1965 - Either Atlantic City or Chicago

Fall 1960 - Stanford, Calif. - Aug. 22-26

1961 - Booomington, Ind. - Sept. 5-8

1962 - Buffalo, N.Y. - 75th Anniversary Meeting of APS.

1963 - Place to be decided by Council at its next meeting.

1964 - Brown Univ., Providence, R.I. - 200th Anniversary of Brown Univ.

NEWLY ELECTED MEMBERS

The following, nominated by the Council, were elected to membership in the American Physiological Society at the Spring meeting, 1960.

FULL MEMBERS

ABBOTT, Bernard C.: Assoc. Prof., Zoology Dept., Univ. of California, L.A.
ALEXANDER, James K.: Dir. Cardiac Lab., Jefferson Davis Hosp., Houston.
BAJUSZ, Eors: Sr. Res. Asst., Inst. Exper. Med. & Surg., Univ. of Montreal.
BALKE, Bruno: Assoc. Prof. Physiol., Air Univ. Randolph AFB.
BARKER, June N.: Instr. in Physiol., Jefferson Med. Coll.
BELLET, Samuel: Dir., Div. Cardiology, Philadelphia Gen. Hosp.
BENNETT, Michael V. L.: Res. Assoc., Dept. Neurol., Coll. P&S, Columbia Univ.
BERMAN, Leonard B.: Chief, Sec. Renal Physiol., Children's Hosp., Washington, D.C.
BOATMAN, Joseph B.: Head, Dept. Res. Physiol., Wm. H. Singer Res. Lab., Pittsburgh.
BRIZZEE, Kenneth R.: Assoc. Prof. Anatomy, Univ. of Utah Sch. of Med.
BROMBERGER-BARNEA, Baruch: Instr., Dept. Physiol., Univ. of Colorado.
BRUST, Manfred: Res. Assoc., Physiol., Inst. for Muscle Diseases, New York.
CHO, Min-Haing: Asst. Prof., Dept. Physiol. & Pharmacol., Wayne State Univ.
COHN, Jerome E.: Dir., Pul. Func. Lab., VA Hosp., Lect., Physiol., Univ. of Utah.
CONWAY, Frederick J.: Instr. in Med., Univ. of Michigan.
COOPER, Theodore: Natl. Neart Inst. Trainee in Cardiovasc. Surg., St. Louis Univ.
CROWELL, Jack W.: Assoc. Prof. Physiol., Univ. of Mississippi Med. Ctr.
CRUMPTON, Charles W.: Assoc. Prof., Dept. Med., Univ. of Wisconsin Med. Sch.
DAWSON, William R.: Asst. Prof., Dept. Zool., Univ. of Michigan.
DEATHERAGE, Bruce H.: Res. Assoc., Deafness Res. Lab., Children's Hosp., L.A.
DEL CASTILLO, Jose: Assoc. Prof., Dept. Pharmacol., Univ. of Puerto Rico.
DENNIS, Warren H.: Asst. in Physiol., Instr. of Comm. Health, Univ. of Louisville.
DENNISTON, Rollin H. II: Prof. Zool. & Physiol., Univ. of Wyoming.
DEPOCAS, Florent: Assoc. Res. Off., Animal Physiol., NRC, Ottawa.
DREILING, David A.: Dir., Pancreatic Res. Lab., Mt. Sinai Hosp., New York

ENGELBERG, Joseph: Instr. Biophysics, Univ. of Colorado Sch. of Med.
FLEMING, David G.: Physiol. Rad. Energy Effects Lab., Gen. Elec. Co., Cleveland.
FLETCHER, Anthony P.: Asst. Prof. Med., Washington Univ. Sch. of Med.
FREINKEL, Norbert: Assoc. in Med., Harvard Med. Sch.
GILBERT, Robert P.: Asst. Prof. Med., Northwestern Univ. Med. Sch.
GORLIN, Richard: Assoc. in Med., Harvard Med. Sch.; Peter Bent Brigham Hosp.
GROSVENOR, Clark E.: Asst. Prof., Dept. of Physiol., Univ. of Tennessee.
HAFEZ, E. Saad E.: Assoc. Prof., Dept. Animal Sci., State Coll. of Washington.
HEGGENESS, Franklin W.: Asst. Prof. Physiol., Univ. of Rochester Sch. of Med.
HERBERT, Victor: Res. Assoc., Thorndike Mem. Lab., Boston City Hosp.
HOLMES, Edward L.: Instr., Dept. Physiol. & Pharmacol., Wayne State Univ.
JOHNSON, John F.: Asst. Prof., Exec. Officer, Dept. Physiol., Wayne State Univ.
JOHNSTON, Charles L., Jr.: Res. Assoc., Dept. Physiol., Univ. of North Carolina.
KAISER, Irwin H.: Assoc. Prof. Obst. & Gyn., Univ. of Minnesota.
KATZ, Yale J.: Assoc. Prof. Med., Univ. of S. Calif.; Invest., Am. Heart Assn.
LAMBOOY, John P.: Assoc. Prof. Physiol., Univ. of Rochester Sch. of Med.
LATEGOLA, Michael T.: Asst. Prof. Physiol., Univ. of Oklahoma Sch. of Med.
LAZO-WASEM, Edgar A.: Res. & Control, Dir. of Control, Wilson Lab., Chicago.
MC DONALD, Leslie E.: Prof., Head Physiol. & Pharmacol., Oklahoma State Univ.
MEFFERD, Roy B., Jr.: Dir., Psych. Res. Lab., Houston VA Hosp.
MILNOR, William R.: Asst. Prof. Med., Johns Hopkins Univ.
MISRAHY, George A.: Res. Assoc., Deafness Res. Lab., Children's Hosp., L.A.
MITCHELL, Jere H.: Res. Assoc., Sr. Asst. Surg., USPHS, N.H.I.
MOOS, Carl: Instr. in Physiol., Univ. of Illinois Coll. of Med.
PSCHEIDT, Gordon R.: Res. Assoc., Neurochemist, Galesburg State Res. Hosp.
REDGATE, Edward S.: Instr., Western Reserve Univ. Sch. of Med.
RENZI, Alfred A.: Sr. Endocrinologist, CIBA Pharm. Products, Inc.
RITCHIE, Joseph M.: Assoc. Prof. Pharmacol., Albert Einstein Coll. of Med.
ROSOMOFF, Hubert L.: Dir., Res. Labs., Dept. Neurol. Surg., Univ. of Pittsburgh.
ROWE, George G.: Assoc. Prof. Med., Univ. of Wisconsin Med. Sch.
RUSS, Clem: Instr. in Physiol. & Pharmacol., Univ. of Pittsburgh Sch. of Med.
SCHERBAUM, Otto H.: Asst. Prof. Zool., Univ. of California, L.A.
SCHILLING, John A.: Prof., Head, Dept. Surg., Univ. of Oklahoma Sch. of Med.

SCHNABEL, Truman G.: Assoc. Prof. Med., Univ. of Pennsylvania.
SELLERS, Alvin F.: Prof., Head, Div. Vet. Physiol. & Pharmacol., Univ. of Minnesota.
SHANZER, Stefan: Res. Asst. in Neurol., Mt. Sinai Hosp., New York.
SHEPARD, Robert S.: Spec. Instr., Dept. Physiol. & Pharmacol., Wayne State Univ.
SJODIN, Raymond A.: Res. Assoc., Purdue Univ.
SLUSHER, Margaret A.: Asst. Res. Anatomist, Dept. Physiol. Chem., Univ. of California, L.A.
STANLEY, Malcolm McC.: Prof. Exper. Med., Univ. of Louisville Sch. of Med.
TAYLOR, Isaac M.: Assoc. Prof. Med., Univ. of North Carolina Sch. of Med.
TRAPANI, Ignatius L.: Res. Fellow, Calif. Inst. of Tech., Pasadena.
WATANABE, Shizuo: Assoc. Prof. Biochem., Dartmouth Med. Sch.
WOLF, Richard C.: Asst. Prof. Physiol., Univ. of Wisconsin.
WOOL, Ira G.: Asst. Prof. Physiol., Univ. of Chicago.
ZECHMAN, Fred W., Jr.: Asst. Prof. Physiol., Miami Univ., Oxford, Ohio.

ASSOCIATE MEMBERS

BOGNER, Phyllis H.: Instr. in Physiol. & Pharmacol., Univ. of Pittsburgh.
CARO, Colin G.: Res. Assoc., Dept. Physiol. & Pharmacol., Univ. of Pennsylvania.
DIAMOND, Sidney P.: Res. Assoc., Central Inst. for the Deaf, St. Louis.
EMERSON, Geraldine M.: Teaching Asst. in Physiol., Univ. of Alabama Med. Ctr.
GOLDSMITH, DALE P. J.: Instr. in Physiol., Univ. of Rochester Sch. of Med.
HEIM, Louise M.: Asst. Prof., Dept. of Biol. Adelphi Coll.
HOOVER, George N.: Acting Jr. Res. Physiol., Dept. Poultry Husb., Univ. of California.
KNAPP, Francis M.: Res. Asst. in Physiol., Univ. of So. California.
LATIMER, Clinton N.: Neurophysiol., Group Leader, Lederle Labs., Pearl River.
MAJOR, Charles W.: Instr., Dept. Physiol., Univ. of Rochester Sch. of Med.
NORRIS, Gail R.: Prof., Chmn., Biol. Dept., Mt. Union Coll.
O'BRIEN, Larry J.: Instr., Dept. Physiol., Albany Med. Coll.
OHR, Eleonore A.: Grad. Student Fellow, Dept. Physiol., Univ. of Rochester.
SCALA, Robert A.: Res. Asst., Toxicol. Inf. Ctr., Natl. Acad. Sc., NRC.
STEVENSON, Robert T.: Staff member, Science Dept., Prof. Biol., Southwest Mo. State Coll.
STOIBER, Alma M.: USPHS Trainee in Neurophysiol., Univ. of Washington Sch. of Med.
TEAS, Donald C.: Spec. Trainee, Natl. Inst. Neurol. Dis. & Blindness, Cent. Inst. for the Deaf, St. Louis.

THE STUDY AND TEACHING OF BIOLOGY

From an introductory lecture delivered by
H. NEWELL MARTIN -- one of the founders
of the American Physiological Society -- at
the Johns Hopkins University, October 23, 1876*

Introduction

We meet tomorrow to formally begin the biological work of this University -- to commence that systematic study of animal and vegetable form and function, relationship and distribution, which we include under the names of Comparative Anatomy, Zoology, Physiology and Botany, or in the general terms Biology or Natural History. I have thought that it might be well today to take an opportunity of laying before you what seem to be the ends which we should hold in view, and the methods on which we should work, if we are to attain or to deserve a permanent success. It is, I am sure, unnecessary for me to dilate at any length, before this audience, upon the interest and importance of biological studies. However contributory to our culture and welfare other studies may be, biology has, and ever must have, a very special interest of its own; it alone deals with the living organisms which surround us, and which are the only things that share with us that wonderful collocation and interaction of natural forces which we call life. Biology, too, includes within its range the study of man himself, so far as one side of his nature is concerned; and, as regards his mental and moral qualities, the psychologist and sociologist have already begun to recognize that the progress of their sciences is closely bound up with the development of certain branches of biology. As regards its practical value I might set forth at length the indebtedness of scientific medicine and of sanitary science to biology; but I prefer not to recommend the study to you by such considerations. This is a university: and the object of a university, I take it, is directly to promote liberality of thought and culture, and only indirectly to concern itself with the practical advancement of material welfare. It is concerned rather with the acquirement of a knowledge of principles than with their practical applications; although, in connection with it, it may have subsidiary schools where those who have already learned the principles may acquire a practical knowledge of various arts. Nevertheless it is true that, if we devote ourselves to the higher objects, the rest will be added unto us; for it is one of the great glories of all the physical sciences that, while second to none in the training which a study of them gives to all the faculties of the mind, in the promotion of large and liberal ideas, and in the gratification of that longing to "know," which is the noblest characteristic of the human intellect -- they at the same time, as a by-thing, but constantly,

*Editors Note: This historical material from eleven years before the founding of our Society, seemed quite apropos in light of the Teaching Session on graduate training held at the Federation Meetings in April.

contribute to the increase of man's comfort, and to the material prosperity and happiness of his race. Those who advance our knowledge of the laws of animal and vegetable life may work without any immediate outlook to the advancement of medicine, hygiene and agriculture, but such advancement constantly follows and springs from their work, and will ever do so.

To those who are in any degree acquainted with the state of the scientific world, the present must seem a specially opportune time for founding a biological school. At no previous period has such an interest been taken in biological problems, or have so many earnest workers been in the field -- never before has so rich a harvest been in view. This is mainly owing to the promulgation of two great ideas within the last few years. On the morphological side we have the doctrine of evolution applied to living forms, and especially as definitely put forward by the theory of the origin of the species by natural selection; while on the physiological side we have the doctrine of the conservation of energy, and its extension to the play of forces in living organisms. It matters not whether these theories be correct representations of the facts or not, or whether increase of knowledge confirms or upsets them -- in any case they have been of incalculable importance in stimulating work and in giving a present and direct significance to its results. I can imagine no time for the biologist to live in which would be more interesting than the coming half-century, or none in which he will have a greater incentive to study; he seems to have almost within his grasp the solution of problems of the widest significance.

Requisites of the Biological Investigator

One hears a good deal talked nowadays of scientific research, and among it a good deal of what I cannot but think mischievous nonsense about the peculiar powers required by scientific investigators. To listen to many, one would suppose that the faculty of adding anything whatever to natural knowledge was one possessed by extremely few persons. I believe, on the contrary, that any man possessed of average ability and somewhat more than average perseverance, is capable, if he will, of doing good original scientific work. Any hard-working and commonly intelligent man, who likes his profession, will make a good soldier, or lawyer, or doctor, though that combination of powers which makes the great general, or the great jurist, or the great physician, is given to but few.

So it is with the pursuit of Science: assuredly not every one of her followers, very probably not one among us now present, will become a Linnaeus, or a Cuvier, or an Agassiz. It may not be given to any of us to make some brilliant discovery, or to first expound some illuminating generalization; but we can, each and all, if we will, do good and valuable work in elucidating the details of various branches of knowledge. All that is needed for such work, besides some leisure, intelligence and common-sense (and the more of each the better), is undaunted perseverance and absolute truthfulness; a perseverance unabated by failure after failure, and a truthfulness incapable of the least perversion (either by way of omission or commission) in the description of an observation or of an experiment, or of the least reluctance to acknowledge an error once it is found to have been made. Moreover, this love of truth must extend to a constant searching and inquisition of the mind, with the perpetual endeavor to keep inferences from observation or experiment unbiased, so far as may be, by natural predilections or favorite theories. Perfect success in such an endeavor is, perhaps, unattainable, but the scientific worker must ever strive after it; theories are necessary to guide and systematize his work, and to lead to its prosecution in new directions, but they must be servants, and not masters. I may, perhaps, seem to be insisting at too great length on a self-evident point; but the more one knows of scientific work and workers, the more does one realize the importance and the difficulty of attaining a perfectly balanced mind and of arriving at an unprejudiced deduction from observation.

I believe, then, that the only absolutely necessary faculties for the scientific investigator are love of his work, perseverance, and truthfulness; to make the great leader and master in science, one of those who cast a new ray of light on our conceptions of the universe, other and far rarer powers are, of course, needed -- the most essential being originality of thought; and, as that cannot be either self-taught or taught from outside but must be born in the bone, all that the rest of us can do when we meet such men is to give them a free course and ungrudging help. That an army may attain its best success, needs indeed that every man be brave and loyal, but it is by no means requisite that every soldier be a brigadier-general; so in the army of Science, there is place for soldiers of all ranks and capabilities -- and, at any rate, we know this, that Nature reveals her secrets, which are her rewards, on no system of purchase or favoritism -- what a man deserves that he gets, every drummer-boy who enters her service carries the marshal's baton in his pocket. His reward will be proportionate to the amount of time and intelligence he devotes to his work; given, in addition, certain opportunities which every one has not for himself, but which it is one great object of such institutions as this to provide for all.

If what I have just stated be the general requisites of the scientific investigator, we have next to inquire what special needs has the biologist: these may all be grouped under the head of preliminary training. He must have a fair knowledge of mechanics, experimental physics, and chemistry; he ought to (I would almost again say he must) be able, besides English, to read at least French and German with facility -- assuredly, if he cannot, he will labor with much toil and sorrow, and the more mathematics he knows, with the present rapid importation of quantitative ideas into biological science, the better for him; and for certain special branches of biological work there are other special needs. No mistake is more disastrous than the idea that a man can be a botanist and nothing more; a zoologist, and nothing more; a physiologist, and nothing more. It is true that no one can be master of all the physical sciences, but it is none the less true that hardly one of them can be entirely neglected by the biologist. Animals and plants are, after all, material objects, and live in accordance with the laws that govern matter; but the manifestations of these laws are so often obscured and complicated by the conditions in which they occur in living things, that the understanding of them is only to be got at by approaching them through their simpler manifestations in inorganic bodies. But, apart from that, definite knowledge of various sciences is constantly required by the biologist. How can one ignorant of physics have any real appreciation of the statement that the transmission of a nervous impulse is accompanied by a molecular alteration in the structure of a nerve-fiber, one sign of which is a certain very definite and peculiar alteration in its electrical properties; or how can one ignorant of chemistry grasp the fundamental statement that muscular work is in the long run dependent on the breaking down of complex chemical molecules into simpler and more stable ones? How can the zoologist or botanist scientifically study the distribution of animals and plants in space unless he has a knowledge of physical geography; or in time, unless he knows something of geology? I need not prolong the list.

Furthermore, no one can properly study any branch of biology without some knowledge of its other divisions. The fundamental laws of animal and vegetable life are identical, and only fully realized by comparison; so, while the scientific botanist, to fully appreciate the facts of his own science, must be something of a zoologist, so must the zoologist know something of plants: no one living being or group of living beings can be properly understood by itself. To take other examples: how is the morphologist to deal with such problems as those presented to him by rudimentary organs, unless he knows something of the functions of parts, which is the special domain of physiology; or, how is he to understand the influence of external conditions in the production and preservation of variations in force, without, again, this knowledge of function? And, as regards the physiologist, he has frequently to search the whole animal and vegetable kingdoms not only to discover those forms which give him the best opportunity of studying certain phenomena, but also to get at those fundamental ideas which lie at the base of his whole science. What general and broad ideas should we have of the contractility of protoplasm if we only knew it in the highly-specialized form of a muscular contraction; or of its irritability, if we only knew it as exhibited in the nervous apparatus of one of the higher animals? It is quite true that, without any breadth of knowledge, a man may collect, label and store away thousands of plants; he may macerate and articulate the most beautiful skeletons; he may cut, stain and mount, the most exquisite microscopic preparations; but assuredly he is not likely to do any work entitled to the name scientific; such mechanical work has its value, no doubt, but it is only preliminary to real scientific work -- which latter requires wide knowledge and extended views, and is more valuable the broader the foundation on which it has been built up.

As regards physiological research, several gentlemen have already consulted me with reference to undertaking investigations in different directions, and of course there is plenty of work to be done should others qualified for it present themselves. One difficulty which I have met with, is that many seem to consider that a physiological investigation can be carried on by devoting to it an hour or two at irregular intervals; I feel quite sure that no good work is likely to be done in that way, and am not inclined to encourage such workers. Some, at least, of those engaged in investigation, will be able to have accommodation in the special rooms, apart from the general laboratory, which have been provided for that purpose.

Biological Teaching

Now let us turn to the other part of our subject, biological teaching: from part of what I have already said you have doubtless gathered something of my views on this matter. If biology be the complicated study that I have endeavored to indicate, it is in the first place clear that, in justice both to the student and his teachers, a certain preliminary training must be insisted upon as a preparation for his admission to a biological laboratory; at least the student must have a fair knowledge of physics and chemistry before he comes there; and, when he gets there, the thing next to insist upon is that his teaching be as largely demonstrative and practical as possible, lectures being made of secondary and laboratory work of primary importance.

It matters not to me where the student gets this preparatory knowledge; whether here or at some other institution. I believe he ought to acquire it largely at school, as a part of general education; but as that seems in the present condition of primary education almost impossible, I shall perhaps best make clear my ideas on the matter if I endeavor to sketch out what I think should be the course gone through by a youth fresh from some high-school or college, where he has got an otherwise sound general education, but without anything more than a sham knowledge of physics, and who enters this university with the intention of qualifying himself for biological research or teaching hereafter; and you will, I hope, forgive me if, with the same object of obtaining clearness, I put what I have to say into a somewhat dogmatic form.

Such a person ought to enter at once upon courses of instruction in experimental physics and chemistry, and devote almost wholly his first year to them; but during the latter part of that year, say between the spring vacation and the end of the session, he would, in addition, go through a course of instruction in what we may call general biology. By that I mean a course of instruction in which he would acquire some knowledge of how to use his microscope and how to dissect, and thus gain a certain amount of that special manipulative dexterity which he will require afterward. He would also gain a general acquaintance with biological ideas, and with the meaning of the more important technical terms; he would gain, for example, a real, because a practical knowledge of what we mean by classification, and of the principles on which classifications are founded; he would learn similarly, with his eyes as well as his ears, what we mean by morphology, and homology, and a host of similar terms; and he would, in addition, acquire a special acquaintance with the structure and actions of certain selected typical animal and vegetable forms. This, then, would finish the first year's work, unless our student should be ignorant of French and German. If so, he ought also to acquire, what is really very easily got, at least a fair reading knowledge of those languages.

At the commencement of his second year the student should enter for two elementary practical courses, one on comparative anatomy and zoology, the other on animal physiology. These courses would, I imagine, last about six months each, and they should be taken pari passu. Each would consist, say, of two lectures a week, and the rest of the time would be filled up with the dissection of typical animals, the performance of the simpler physiological experiments, and the preparation and examination of microscopic specimens of animal tissues, all illustrative of the main points put forward in the lectures. The student would also be made to draw sketches of his dissections and microscopic preparations, and to describe them and the results of his experiments briefly in writing, and so while learning thoroughly how to dssect and use his microscope, and the conditions of success in physiological experiment, he would also have his powers of observation regularly trained and tested.

In connection with these courses there should be a museum, containing not a bewildering multitude of specimens, but a small number of dissections and skeletons of typical animals, especially of those which it is important for the student to know, but which are too rare to be obtained in quantities allowing each to dissect one for himself; and these specimens should be so placed that they may be freely accessible to those desiring to study them. It is far better to have to replace an injured specimen occasionally, than to have the things locked up behind glass doors, so as to render their thorough examination impracticable to those for whose examination they are placed there. Moreover, especially in connection with the physiological course, there would be needed from time to time, according to the subject-matter of the lectures, demonstrations of certain points; in cases, for instance, needing the employment of the more delicate instruments, or where niceties of manipulation were required, such as a beginner could not be fairly expected to overcome.

The last three months of the student's second year should be occupied with a laboratory course of instruction in vegetable morphology and physiology, and with a course of lectures on embryology, accompanied with a full practical study of the development of the chick from the earliest stages of incubation.

The student will have now got an extensive acquaintance with biological facts and methods, and henceforth he should be allowed and encouraged to specialize his work. He would be permitted to select for more detailed study in his third year either animal morphology, or botany, or physiology, and the best men in each subject would be picked out and allowed to act as demonstrators to the second-year students, and so be given the opportunity of acquiring a far more accurate knowledge than they could attain in any other way. For these third-year men, too, short advanced courses of lectures would be given from time to time, such as on the physiology of nutrition, the physiology of the senses, the geographical distribution of animals, on special morphological points, and so on, and also on the more important recent discoveries in various branches; and the best of them might be put on some easy bit of original work, to try their metal and whet their appetites.

After all this has been gone through, I think we can do no more in the way of teaching for our typical student; he has now advanced enough to teach himself, and, if he is good for anything, will do it better than others can do it for him. I think that among students so taught, as I have endeavored to indicate, we should be certain to meet with a large number of well-qualified men from among whom to select some of our fellows and associates, and would be justified in expecting from them work of the highest quality. As regards the remainder, those who display no special aptitude for scientific investigation, or no desire to devote themselves to science as a profession, they will at least have had the opportunity of acquiring a very thorough and practical knowledge of what modern biology means.

Conclusion

In conclusion, let me say a word to those of you here present who are to be the first workers with me in this laboratory. It behooves you as well as me to recognize what a heavy responsibility lies upon us. Upon the work that we do and the spirit in which we do it, upon the character we give our laboratory at its start, much of its future success or failure depends. If we all work honestly and thoroughly, it will win esteem and reputation; if we are careless and half-hearted, it will become of low repute. Let us, then, each work loyally, earnestly, truthfully, so that when the time comes, as it will come sooner or later, in one way or another, to each of us, to depart hence, we may carry with us a good conscience, and be able to say that in our time no slipshod piece of work ever left the laboratory; that no error we knew of was persisted in; that our only desire was to know the truth. Let us leave a record which, if it perchance contain the history of no great feat in the memory of which our successors will glory, will at least contain not one jot or one tittle of which they can be ashamed.

ATTENTION -- TEACHERS OF PHYSIOLOGY

The Education Committee of the APS is compiling a series of new and/or unusual experiments illustrating important physiological concepts for use in the teaching of elementary human physiology. It is planned that these experiments will be readily available and it is hoped that they will be most useful to teachers of physiology and human biology in colleges and universities. Your contributions are urgently needed and will be gratefully received by Dr. Charlotte Haywood, Department of Physiology, Mount Holyoke College, South Hadley, Massachusetts.

AMERICAN PHYSIOLOGICAL SOCIETY PUBLICATIONS: HISTORY AND POLICY

MAURICE B. VISSCHER
Chairman, Board of Publication Trustees 1954-1959

The history of publication in the field of physiology in North America is an informative record of the attempts both on the part of individual scientists and of the American Physiological Society to contribute to the development of physiological science by providing better means of communication. Sixty-three years ago, the first issue of the AMERICAN JOURNAL OF PHYSIOLOGY appeared. Volume 197 was completed in 1959. Although in the meantime more than a dozen other journals of primary publication have been established in North America which publish papers either exclusively or partly in the field of physiology, the AMERICAN JOURNAL OF PHYSIOLOGY remains as the foremost medium in the field.

The establishment of the AMERICAN JOURNAL OF PHYSIOLOGY marked an important milestone in New World physiological science. Without a journal, the physiologists of North America were bound to Europe for all intellectual exchange as the fetus is to its mother. The establishment of a separate means of publication was like cutting the umbilical cord of the baby. From then onward the infant was on its own. Fortunately, European science was still available to help the growth of American physiology, but the relationship over the past sixty years has been one of progressively increasing equality of assistance.

It is worthy of note that the founding of the AMERICAN JOURNAL OF PHYSIOLOGY was accomplished when it was because of the vision, courage and generosity of one man, Dr. W. T. Porter. The membership of the Society was apprehensive about undertaking a venture which seemed to offer some financial risk, in spite of the fact that members recognized the advantages to be gained.

Porter was an essentially pragmatic person. He recognized that the tools of a scholar are indispensible. He was responsible not only for founding a journal to communicate ideas and observations to promote the intellectual growth of American physiology, but he was also the person who established a non-profit corporation, the Harvard Apparatus Company, to provide physiological laboratory equipment at cost-of-production prices to promote laboratory instruction and research in physiology.

The American Physiological Society and indeed, society-at-large, owes William T. Porter a debt that has not yet been adequately recognized or recorded. The Porter Fellowships, which are supported out of income from the Harvard Apparatus Company, are the most evident tokens of his foresight, generosity, and high-mindedness of purpose, but it remains true that most physiologists either never knew or have forgotten the enlightened and farseeing nature of his practical services. Too often one takes the advantage one inherits for granted, as one's obvious just desserts, without recalling or thinking to inquire about how it all happened. Without William T. Porter, it is doubtful that American physiological science could have progressed as it has. Certainly, unless someone else could and would have played his several important roles, it would not.

In his characteristically self-effacing way, Dr. Porter offered a contract with the Society under which "a member of the Physiological Society guarantees the publication of the first five volumes." In his letter announcing the Journal, October 20, 1897, he stated that it would be edited by A. P. Bowditch, R. H. Chittenden, W. H. Howell, F. S. Lee, Jacques Loeb, W. P. Lombard and W. T. Porter. The contract with the Society defining its part in the management was as follows:

1. To appoint a publication committee which shall have control of the editorial management of the proposed journal. W. T. Porter shall be secretary of this committee until the expiration of this contract.

2. To state on the cover of the Journal that the AJP is edited for the APS. To give effect to the agreement the Society adopted the following resolution.

> Resolved (1) Six or seven members of the Society shall constitute a committee for the publication of original investigations in Physiology. (2) The Publication Committee shall contract in the name of the Society for the publication of five volumes of an AMERICAN JOURNAL OF PHYSIOLOGY to appear in such a form and at such intervals as are satisfactory to the Committee: provided that the Society shall be free from all financial responsibility. (3) The President of the Society shall be ex officio a member of the Publication Committee and shall appoint or reappoint annually the remaining members, subject to the approval of the Society.

By 1914 thirty-three volumes of the AJP had been issued under contracts between Porter and the APS, but he had found the duties of acting as a kind of managing editor as well as business manager too arduous to continue. He undoubtedly felt that the gestation period of the Journal should be about complete and he was ready to deliver it to the Society. This he did, again with a generosity characteristic of him, donating the copyright to the Society. The Council of the latter accepted the gift and some of the responsibility, and announced that:

"Until a permanent arrangement is made at the next annual meeting of the Society, the business affairs of the Journal will be managed by the Treasurer, Dr. Joseph Erlanger, and the editorial work will be in charge of the Editorial Committee, Dr. W. H. Howell, Chairman." Carlson, Erlanger, Lee, Lusk, Macallum, and Porter were menbers of the Committee.

At the next annual meeting, December 1914, this action of the Council was formally approved by the Society. Dr. Porter meanwhile had resigned his editorship and membership on the Editorial Committee, and the Council, on the nomination of the Editorial Committee, had appointed Dr. Hooker Managing Editor of the Journal and a member of the Editorial Committee. With the beginning of the 34th volume Dr. Donald R. Hooker became Managing Editor and was given control also of the financial affairs of the Journal.

There was, however, a certain financial timidity about the action of the Society in this whole matter. In its Bylaws from 1914 to 1923 the Society provided that

> "At the annual meeting, the President then in office shall appoint, subject to the approval of the Society, five or six members to form with him an Editorial Committee on the Publication of the AMERICAN JOURNAL OF PHYSIOLOGY during the next calendar year. This Committee shall have no authority to involve the Society in any financial responsibility for the publication of the Journal."

Obviously, in accepting the Porter gift of the Journal, the Society was still worried about the monetary obligation it might be assuming and threw that load in reality directly on the shoulders of Donald Hooker. He proved much more than equal to the task of maintaining simple solvency, however, and was able before he finished his career as Managing Editor to put the Publications fund of the Society on a very firm basis. He deserves high praise both for his astute financial management and also for his very high standards of editorial conduct of the Journal.

From 1914 to 1933 Dr. Hooker was responsible directly to the Council of the Society and the Editorial Board disappeared. The AJP was undoubtedly very efficiently managed, but because of lack of definitive control, the editorial functions became the subject of considerable dissatisfaction. The difficulties undoubtedly arose in large part because the Council had numerous other responsibilities in the management of the Society and did not give Hooker the assistance he needed to arrange for more satisfactory editorial review procedures. Members with long service on the Council recognized the maladjustments in the situation and at the 1932 meeting decided to create a special committee to study the whole problem of editorial supervision of the publications and to report back recommendations for its better coordination. The president appointed Doctors Murlin, Ivy and Drinker to this committee. Dr. Murlin soon resigned and Dr. Meek was appointed to the vacancy, Dr. Ivy becoming the chairman. The plan presented recommended the establishment of a permanent committee which should become the responsible unit through which publication problems of all kinds could be cleared. This committee was designated the "Board of Publication Trustees." The Board was given complete authority, financial and otherwise, over publications. The Board was made responsible to and required to report annually to the Council. The members on the Board were to be "appointed by the President of the Society from the members of the Society, in consultation with the Council." The recommendation was based on a recognition of the need to establish efficient control of publications through a special permanent administrative unit with adequate power. The

Society promptly adopted the plan recommended and Dr. Hooker was reappointed as managing editor.

This plan was authorized by action of the Society in April, 1933 as follows:

> "The members of the Board shall serve each for three years, may be subject to reappointment, and may hold office concurrently in the Society. At the first appointment one member shall be appointed for three years, one for two years, and one for one year, in order that in the future appointments may be made in rotation. The Board of Publication Trustees shall meet annually and report to the Council.
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> "...The special functions of the Board of Publication Trustees shall be to consider and investigate thoroughly all matter pertaining to the fiscal and editorial policies of the Journals which may come to the Council, to the Managing Editor, and to members of the Board. The Board shall make recommendations to the Council concerning (1) the administration of the finances of the Journals, (2) the publication policies of the Journals, and (3) the election of a Managing Editor and the assignment of an honorarium to him. The Board shall have the power to advise the Managing Editor and act on urgent matters that arise between regular sessions of the Council. The Board shall recommend to the Council for election the names of members of the Society who shall serve on the Boards of Editors of the Journals. The Board shall meet with the Managing Editor prior to the regular annual session.
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> "The Council, on recommendation of the Board of Publication Trustees, shall elect a Board of Editors for the AMERICAN JOURNAL OF PHYSIOLOGY, consisting of eight members, each editor to serve for three years and to be chosen preferably so that the major fields of physiological research shall be represented. The Editorial Board of PHYSIOLOGICAL REVIEWS shall be continued, except that henceforth nominations for the Board of Editors are to be made to the Council by the Board of Publication Trustees.
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> "The Board(s) of Editors of the Journals shall meet annually or on the call of the Managing Editor, during the regular meetings of the Society, and may make recommendations to the Board of Publication Trustees concerning the improvement of the publication policies of the Journals."

A controversy arose in the mid-1940's about the propriety of the use of income from the publications of the Society for purposes extraneous to the publishing enterprises of the Society, which occurred by a vote of the Society itself, but seemed to many members as well as to the BPT to have been ill advised even if well intentioned. It was an appropriation to assist physiological publication in another country which had experienced great hardships in the war. Primarily, therefore, in order to make "impulse" diversion of such funds more unlikely, the Society in 1940 adopted an amendment to its Constitution which altered previous arrangements only by stating in essence that the BPT and the Council must agree on any diversion of funds from Society Publications purposes.

In 1953 the APS Constitution and Bylaws were extensively revised. The Constitution was limited to two Articles: The name and the purpose of the organization. The latter was very simply stated to be "to promote the increase of physiological knowledge and its utilization." Under this charge, the publication function operates under Bylaw Article V which reads in part as follows:

> "A Board of Publication Trustees, composed of three members of the Society and appointed by the Council, shall be vested with full power of the Society to control and manage, both editorially and financially, all of the publications of the Society; to appoint editorial boards; to appoint and compensate a Managing Editor; and to control all publication funds, none of which, however, may be diverted from support of the publications of the Society except by consent of the Council.... The Council shall designate the Chairman of the Board, and shall receive an annual report on the finances, publications and policies. A summary of the report shall be presented to the Society at the Spring meeting.'

The editorial arrangements for the AJP under the new Board of Publication Trustees became from 1933 the major problem of that Board, and many scores of members of the Society have since that time served as members of the Editorial Board. There are real virtues in spreading editorial responsibilities widely. First, and most important, in this way a Journal avoids parochialism. Second, it prevents the occurrence of personal proprietary control by a few people, which is a calamity when it occurs, regardless of the competence of the persons involved. Third, it makes more people aware of the real problems of editing a scientific journal. They become less impatient with editorial criticism of their own papers. Fourth, the load of work is spread in a more equitable way. Editorial Board service is a labor of love, but it can be a very burdensome job and is becoming more so by the year.

In 1946 Donald Hooker became ill and his associates at Johns Hopkins University, particularly Philip Bard, kept the APS publications going. At that time the BPT, and particularly its chairman, Andrew Ivy, recognized the need for a full-time officer to serve the needs of the Publication enterprise of the Society and of the executive management of the Society and the Federation. By pooling resources, it seemed that this might become a reality. In particular, it was possible because through prudent management, Donald Hooker had built up a Publications reserve, the income from which would support a half of the salary of an appropriate person. Obviously, it was necessary to have a scientist in this position and since a half of his work was to be in editing physiological publications, it seemed appropriate that he should be a physiologist. Fortunately, the opportunity appealed to Dr. Milton Lee, who had previously had experience as Managing Editor of the journals "Endocrinology" and "Journal of Clinical Endocrinology" and who, during World War II, had extensive administrative experience. As Managing Editor of the APS publications since June 1947, he has done a remarkable job in helping to provide the mechanisms for meeting the expanding publication needs of physiological science.

There is much popular interest today in the "population explosion" and what to do about it. There has been relatively an even greater post-war "publication explosion" in science and the APS can undoubtedly be pleased with the fact that its publications functions have met the needs of this explosion with considerable completeness as to volume and with maintenance of high standards.

Nothing specific has been said till now about publications other than the AMERICAN JOURNAL OF PHYSIOLOGY. In 1921 PHYSIOLOGICAL REVIEWS was begun in response to the obvious need for such a publication in the English language. In 1948, again in response to a felt need, the JOURNAL OF APPLIED PHYSIOLOGY was initiated. In 1958 THE PHYSIOLOGIST was established as a "house organ" for the American Physiological Society and as a medium for publication of various types of material better suited to it than to the other three journals. It has already become an indispensable publication medium for the Society. It is supported, as far as member subscriptions are concerned, essentially out of income from the Publications Permanent Fund.

The BPT has also assisted communication in the physiological sciences by the publication of several monographs and books such as the "Mirror To Physiology" presenting the results of a study sponsored by the National Science Foundation and the APS. Among the list of monographs are several sponsored jointly by the NSF, the Society of General Physiologists and the APS. In this way the APS has attempted to be helpful to communication in the general physiology field.

The most recent addition to the major publication activities of the Society is the "Handbook of Physiology." The first two of three volumes in the first section -- Neurophysiology -- have appeared and other sections are in process of preparation. This venture is believed to be the first of its kind to be sponsored and financed entirely by a scientific society. If early indications are borne out, it will be a completely self-sustaining venture.

In writing about the recent history of the Board of Publication Trustees another collateral service to American physiology should be mentioned. About ten years ago, it became apparent that the space so generously provided by the National Academy of Sciences -- National Research Council at 2101 Constitution Avenue in Washington was inadequate to house the executive and publication activities of the APS. Various possibilities for more ample permanent housing were explored. Dr. W. F. Hamilton became much interested in this problem. Dr. Lee and he discovered that what is now Beaumont House at 9650 Wisconsin Avenue was available for purchase at a price which made it likely that by the sale of the undeveloped land around the mansion the latter could be obtained at an extremely low cost. The mansion was suitable for conversion to the uses in question, but it seemed much too large for the then foreseeable needs of the APS. Dr. Wallace Fenn, the then chairman of the Board of Publication Trustees, considered that the purchase should be made only if the Federation would become the owner, and each of the Federated Societies would have an option to utilize portions of the building for executive or publications office use. The Council of the APS was consulted and it was wholeheartedly in favor of the purchase as well as of the offer to the Federation to sell it to the latter at the figure of the cost to the Society. Therefore, the necessary part of the permanent Publications fund of the Society was employed to purchase Beaumont House and associated grounds. As was anticipated, the sale of the larger part of the grounds reduced the cost to the Federation of the house and presently retained grounds to a small figure, a minor fraction of what the house and grounds could be sold for. Thus, at no ultimate expense to the APS itself, the Federated Societies have been provided with as elegant, appropriate and useful a permanent office building as might be obtained. The APS can feel a certain satisfaction in the fact that the existence of its Publications enterprise, and particularly the permanent fund so carefully husbanded initially by Donald Hooker and later by all of the officers of the Society, made possible the provision of this great asset to the current life and work of all of the Federated Societies.

The general philosophy of the Board of Publication Trustees during the twenty-seven years of its service to the American Physiological Society has been, as will be obvious from the record, one of dynamic responsiveness to the evolving needs of American physiological science in the field of publishing. It has attempted to maintain high standards of editorial policy without imposing censorship of ideas. It has attempted to spread the labor of editorial work as widely as possible, both to avoid overburdening a few, and to prevent the occurrence of entrenched bias. It has considered it to be its duty to undertake new publishing ventures as the physiological scientific enterprise in the country and the world has grown. The publication work of the Society is now in a flourishing condition both editorially and economically. Its present state is a validation of the vision of Porter, Hooker, Meek, Ivy and Fenn, to mention again a few of those who contributed greatly to its solid service and growth.

The American Physiological Society may well take pride in the fact that it has been an innovator rather than an imitator in its publications activities. It is interesting to speculate as to why it may have been more successful than most other societies. One fact of interest and likely importance is that in the sixty-three years of its existence, the AMERICAN JOURNAL OF PHYSIOLOGY has had only three major editors and that they have all been managing editors responsible not only for the editorial content, with the help of editorial boards, but simultaneously responsible for the management of the economy of the publications. In many other societies these functions have been separate and the journals have not fared so well. The APS has been fortunate in the long tenure of service of its managing editors. There is no substitute for experience in the overall management of journals. It may also be noted that the concentration of responsibility and authority for publication activities in a small Board of Publication Trustees is rather unique. By very careful selection, the Council of the Society has made sure that a group of knowledgeable and devoted persons has thereby been made to feel great responsibility to the Society in publication matters. These persons have devoted large amounts of time and attention to the work. There may easily be an important connection between this mechanism of control by the Society and the unquestionable success of its publication program.

In the last analysis the devotion of the members of the Society to the publication program is without doubt the largest single factor in its usefulness and success. Without the hard work of editorial boards, without the cooperative spirit of the entire membership and without the tradition of democratic procedure in the Society, the publications enterprise could not have attained its present state of secure usefulness.

The future of the publication work of the Society is something no one can predict with certainty. The exponential rate of growth which physiological science is experiencing will demand continuous attention to mechanisms of communication, to means of storage and retrieval of information. It may easily be that our present methods will be obsolete within a decade. The American Physiological Society must be willing and able to pioneer in whatever new solutions to the problem need to be explored. If it maintains its present and past policies, it will be able to do so.

GRANTS-IN-AID FOR STUDIES ON ALCOHOLISM AND RELATED SUBJECTS

The Scientific Advisory Committee of Licensed Beverage Industries, Inc. is offering grants for research in the biological and behavioral sciences to obtain more scientific information both as to the extent of alcoholism and as to its causes and treatments. Grants range from $2,000 to $10,000 per annum. Application forms and detailed information may be obtained from the Scientific Advisory Committee of the Licensed Beverage Industries, Inc., 155 East 44th Street, New York 17, N.Y.

AMERICAN PHYSIOLOGICAL SOCIETY JOURNALS: EDITORIAL PROCEDURES AND PRACTICES

MILTON O. LEE, Managing Editor

Over the past ten years there have been introduced many new practices and procedures in the editorial office of the APS Journals, and modifications of existing practices have been made. Some experiments have not turned out as well as hoped and have been abandoned or further modified. While experimentation continues, many procedures have now become well established and routine. Some of these that are of particular interest to APS members and authors are described below.

Our Journals continue to grow. We now receive around a thousand manuscripts per year for the AJP and the JAP -- an average of four for every working day. We have long abandoned the policy of restricting the Journals to a predetermined or budgeted number of pages per year, and presently the only bases of decision for acceptability of a paper are: a) the quality of the scientific content and b) the quality of the presentations. In 1959 the AJP and JAP together published 796 papers and about 4.3 million words. If, and as, the pressure of physiological papers increases, our Journals are prepared to publish all of the acceptable ones, a circumstance that is not very common among biological journals.

Acceptability of Papers. Papers submitted to the AJP and the JAP are referred to at least one of the 56 members of the combined Editorial Board, matching as closely as possible the field of the paper with the special interest and competence of the referee editor. Often a paper is referred to two editors simultaneously or to several editors in succession, depending upon the questions raised and the criticisms made. The editors write on the form sheet accompanying the manuscript their comments, suggestions, objections or praise of the paper. They also make two rating judgments. The more important one is on the scientific quality of the work reported: Category 1 means outstanding, extremely important work that advances physiology considerably in a fairly broad area; Category 2 means very good work that advances a narrower segment of physiology significantly; Category 3 papers are those that are acceptable in substance because they supply some useful and needed information in narrow or specific areas; Category 4 means unacceptable for reasons that the editors detail. The second rating pertains to the quality of the presentation of the material: A indicates excellent presentation, concise, clear and well organized, with tables and figures carefully "tailored" for the Journal; B means that minor or major revision or even complete rewriting is needed. About 60% of papers submitted and eventually accepted are returned to authors for revisions of one sort or another, i.e., are given a B rating. This system of rating of papers has been adopted by several other journals.

Speed of Publication. It is the aim of the Editorial Office that acceptable papers suffer as little delay in publication as possible. The process of editorial scrutiny and acceptance takes a variable time, depending on the promptness of referee editors in returning manuscripts and the pressure of other duties on the Managing Editor. Papers returned to authors for revision suffer delay that depends on the author, and upon subsequent referral again to editors when necessary. Each paper when published carries the date of original receipt of the paper by the Editorial Office, except for papers that take a long time in revision. After acceptance, the promptness of publication depends to some extent on the quality of the presentation. Papers that conform closely to our specifications -- that are carefully typed, author-edited for grammar, punctuation, accuracy and completeness of references, whose presentation is precise and concise, with figures in good order and well lettered, and with tables carefully tailored, well planned and typed -- offer few problems and go through editorial procedures quickly. They may appear in print one to three issues ahead of papers received at the same time that present problems and require much editorial work. For these reasons as well as by deliberate policy, authors whose papers are excellently prepared are rewarded by minimal delay in publication. This will become even more noticeable as we are able to decrease the time required by the printer in manufacture of the Journals.

One person in the Editorial Office devotes full time to the preparation, sizing and arrangement of figures for the engraver. We achieve considerable economy on engravings by mounting many line cuts, for the same reduction, for photographing and etching on large-size plates, then sawing the individual figures apart for final mounting on blocks for printing. Largely for this reason we wish to work from photographs of figures, submitted unmounted, rather than from original drawings or records. Even with recent increases in the cost of engravings, they are still less expensive than tabular material of equal area because the skilled labor involved is less.

Author Charges. The basis for these apparently is not well understood, so the following information is given. Mathematical expressions and formulas, chemical formulas, tabular material and figures are the most expensive elements in the publication of a paper, in the order listed, since all involve expensive, skilled hand-labor. Prior to 1948 the policy of the AJP was to place an absolute space limit, about 15% of the length of a paper, on tables and figures. Under present policy the editors may permit any amount of tabular and illustrative material that they consider to be necessary or desirable documentation, provided the excess cost over the Journal's free allowance can be borne by the supporting funds of the research.

Excess charges for our journals are calculated as follows. The cost of composition of tables and their footnotes, the cost of engravings and composition of figure legends, and the cost of composition of formulas are estimated, then the Journal's free allowance of $35 to $50 per paper is deducted. The amount of the free allowance depends upon the excellence of the figures and tables the author submits. If they are very poor and require much work in our office, the allowance is minimal; if they are excellently tailored for the journal columns, the allowance is maximal.

Costs of engravings and their legends average about $10 per figure, but size and shape are factors in cost. Tables are more expensive than figures and table column heads are much more expensive than equivalent space in the body of the table. A page filled with a single table with simple heads costs about $55; a page filled with six tables with boxed heads may cost as much as $150. A simple table with say six lines of data, with five or six columns and without a boxed head or rules may cost as little as $10. Tables that occupy only half-page width are half as expensive as those of the same height that have to spread across the page. Tightness is often due to long, wordy column-heads, so abbreviations are used where possible. Seven table column-heads usually fill a printed column in width.

In case where there is duplication of data in figures, text and/or tables and if the referee editors are willing to allow the duplication, the author's charge is increased to cover the extra makeup and manufacturing costs resulting.

Author's alterations in proof whether they be small or extensive require the attention of at least five skilled people. Hence the charges are high ($8.50 per hour), even for minor changes. The Journal's free allowance is $5. This is one reason for returning many manuscripts to authors for revision and polishing before acceptance.

Among biological journals in this country there is an increasing inclination to adopt a page charge for publication, on a basis such as is used by the journals in the field of physics and by the Society for Experimental Biology and Medicine. It is possible that the APS Journals along with other biological journals will institute such a policy within a few years. The logical basis is that new scientific information, usually published in journals, is the only product resulting from the vast funds that support the research work. Without publication or some mechanism for getting information into retrieval systems for widespread use, the investment of money in the research is largely futile. An "insurance charge" of 5% of research grant and project funds, taken at the source of those funds, would provide well for all the financial aid needed by journals of primary publication, abstracting and indexing services, certain information services, and many of the media of tertiary publication (reviews and compendia). Until some system of assessment on research funds at their source is developed, it would seem desirable for all research grant applications to carry in their budgets an item of say 2% for publication charges in primary journals. All government agencies now allow such an item in research proposal budgets, and many private sources of funds have long recognized the principle. Most of us personally spend at least 5% of our income for insurance of various types. It is surely a sound insurance policy to provide for the permanent availability of new scientific information.

It is also our editorial policy to assess no publication charges that cannot be borne by the supporting funds of the authors. The ways to keep publication charges minimal and also to aid readers are obvious but often neglected: concisely written, well-organized text; expertly planned and carefully tailored tables; use of statistical summary tables where appropriate; well-planned, well-lettered, properly-scaled figures submitted as unmounted, glossy photographs; avoidance of duplication of data in text, tables and figures. Papers that observe these matters get the favorable breaks, both in respect to author charges, if any, and in promptness of publication.

Our Journals are published by the American Physiological Society, as are most of our books, i.e. we handle a complete publication service. We purchase from our printer only services for composition, makeready, presswork, binding, and wrapping in mail-covers addressed by us.

Abstracts, Titles. Again the APS has taken a lead among biological journals in undertaking the detailed cooperation with abstracting, indexing and bibliographic services that is effective and meaningful. The Publication Trustees understand thoroughly that primary publication in itself falls far short of the desirable goal of making new information widely known, retrievable and available. We have agreed to require specific and substantive but short titles (not longer than 85 characters) to papers, omitting unnecessary and useless words and general titles. We publish an informative type abstract of each regular paper in 170 words or less, which may be used by any abstracting service. We supply these abstracts in page proof form, when the complete citation is first available, to the large abstracting services in Russia, England, and of course to our own "Biological Abstracts." We also supply tables of contents at the time of page proof to titling and indexing services here and abroad. This means that titles and abstracts of papers can appear very promptly in the secondary media, sometimes before the paper itself is out.

As a further aid to information retrieval systems we plan, as soon as practicable, to carry a code term with each article and abstract which will describe the content of the paper. Such a code term should be translatable into the particular language of any mechanical system, from simple ones to computers. Its inception depends upon the development of a suitable classification of biology so that the same system can be used by any other biological journal anywhere in the world. Through the NAS and with the aid and interest of the NSF, steps are under way that may lead to the development of a suitable classification system.

We are much concerned that the quality of author-prepared abstracts be maintained at a very high level and are seeking ways for some improvement in quality of those we publish.

PHYSIOLOGICAL REVIEWS demands somewhat different practices than those of our journals of primary publication. Its papers are mostly invited ones that usually require a year or more in preparation. These are intended to be scholarly, critical, analytical, comprehensive reviews of topics or areas of physiological science. Although for the most part authors and topics are selected by the editorial board, volunteer reviews may be submitted and are carefully considered. Their mortality is high simply because many of their authors merely summarize the literature of a field and do not add the essential ingredient of unbiased critical analysis.

Following the dislocation of the war years, the issues of PHYSIOLOGICAL REVIEWS were rather thin. Now, with the formation of a European Committee to aid in securing reviews from abroad, with the vigorous leadership of Dr. H. S. Mayerson as Chairman of the Editorial Board, and with the constant services that Dr. Ray Daggs supplies in gently reminding authors of their commitments, our volumes are increasing in size again.

The REVIEWS also publishes occasional supplements, mostly to date, of long annotated bibliographies in specific fields.

Copyrights. All of the publications of the APS are now copyrighted for the protection of both the Society and our authors. Important for both is protection against "lifting" out of context by the various antivivisection groups. They still violate our copyright and, in a rather desultory way, we collect evidence of violation for use in legal action if such should become necessary. We regard the authors of papers as sharing our copyrights and usually do not give permissions to copy without the consent of authors. However, we are well aware of the impediments to the flow of scientific information that unwise restriction through the copyright can impose. Hence, we allow and encourage "lifting" of abstracts without specific permission or acknowledgment by any responsible abstracting service, and are glad to allow reproduction of whole papers by libraries and institutions for the use of individuals.

Back Volumes and Issues. One of the obligations of a scientific journal is to insure that back volumes and issues are available for many years, particularly so that new libraries and institutions can acquire complete sets and so that losses by libraries can be replaced. The APS formerly maintained such stocks, though incomplete, and sold them at a loss because of storage and servicing costs. We now maintain stocks only for a period of three years during which demand is greatest, and have arranged the following mechanisms for permanent availability: a) Remaining back copies after three years are sold to the Johnson Reprint Corporation, which has agreed to reprint any out-of-stock issues or volumes upon demand; b) microfilm editions are made and distributed by University Microfilms, Inc., Ann Arbor, Michigan; c) microcard editions of certain volumes are available from J. S. Canner Co., Boston. The Board of Publication Trustees have authorized current editions of AJP, JAP and PRV in microcard form, to be issued, stocked and sold through the Editorial Office. This plan has not yet been started, however.

Discounts and Subscripion Rates. The APS Journals have taken the lead in refusing to allow discounts to subscription agencies, and the policy has been adopted by numerous other scientific journals despite the pleas of the agencies. Most libraries and institutions find it advantageous to group all their subscriptions to journals and magazines and give their whole order to the agency which makes the lowest bid. The agency lives on the discounts it receives, yet renders no service to the journals either in promotion or in bookkeeping and accounting. Our position has consistently been that those who benefit from such agency handling, the libraries and institutions, should pay a surcharge of around 10% to the agency. As a result, all of our subscriptions except those to APS members are at full price, cash or purchase order in advance. This policy has eliminated considerable annual losses to to the Journals both through uncollectable accounts and the complicated bookkeeping, collecting and accounting procedures necessary when credit is allowed. We and others who have adopted the policy have found that it has not decreased circulations.

Members of the APS may subscribe to the AJP and/or the JAP at a discount of 50%. This is below the cost of production and distribution of the Journals and is the maximum permitted by 2nd class postal regulations. It is possible largely because only relatively few members subscribe personally to these Journals. The Internal Revenue Service is concerned about such large discounts by tax-exempt organizations and consider that they are, in effect, dividends to members that are subsidized by non-member subscribers. Our liberal policy of member discounts may have to be revised.

Even at full subscription rates our Journals compare very favorably with other scientific journals in the cost to the subscriber. The cost of ours is around $1.40 per 100M words, close to the cost of a number of other well-managed journals of larger circulations, and considerably less than for many biological journals. We have some reason to consider that the ratio of information to words, if it could be measured, is relatively high in our Journals.

Exchanges. Our Journals are not given free or exchanged except with other journals of the Federated Societies and a very few other organizations for specific purposes. Yet we receive a great many requests for exchange, some of which we would like to grant. A possible solution to this problem is under consideration by the Conference of Biological Editors, through which a Center for handling exchanges of biological journals might be established. Exchanges which we approve would be handled through the Center and we would receive about 75% of the regular subscription price, this to be paid at least in part by subsidies to the Center. This would allow certain desirable exchanges at low cost to the foreign recipients and thereby increase the use of our Journals abroad.

Use of Experimental Animals. The Council of the APS has recently become concerned over the number of papers which describe experiments using unanesthetized animals. Some of these experiments could be interpreted by laymen as involving pain or cruelty and an improper use of experimental animals. This is a very serious matter for American physiology and could lead through the vicious efforts of antivivisection groups to the loss of the privileges of proper experimentation that are essential to physiology and which have been preserved, precariously, at considerable cost and effort. For the Journals, we require conformance with the codes of the APS and the AMA. Any papers for which the question is raised by an editor are given particularly careful scrutiny and may be referred to the Trustees. Some authors now submit with their papers an affirmation on the form devised by the AMA Committee. This is a useful and desirable practice.

Style Manual. The Conference of Biological Editors has prepared a Style Manual for Biological Journals. We have participated in the preparation of this and our Journals along with about fifty others have adopted it for their standard practice. It is also intended for the use of authors. As soon as it is published and available (Fall 1960) we shall refer authors to it constantly for guidance in the preparation or revision of their papers. We will shrink our own "Information to Authors" as carried in our Journals to a much smaller size and refer authors to the Style Manual for all the details that it covers. It is very encouraging that a single style manual can be officially adopted by so many biological journals, and its utility to both authors and editors is obvious. This project of the Conference of Biological Editors is only one of its numerous activities in studies, cooperative ventures, standardization and information sharing.

SECOND INTERNATIONAL BIOCLIMATOLOGICAL CONGRESS

The International Society of Bioclimatology and Biometeorology will hold its second Congress in London, England, September 4-10, 1960. The meetings will be held in the rooms of the Royal Society of Medicine, 1 Wimpole Street, London W 1. The main themes of the Congress will be: High Altitude Bioclimatology; Tropical Bioclimatology; Bioclimatic Classifications; and Meteoro-Pathological Forecasting.

The Secretary-General of the Congress is Dr. Solco W. Tromp, Hofbrouckerlaan 54, Oegstgeest (Leiden), Holland. The President of the International Society is Dr. F. Sargent, Dept. of Physiology, University of Illinois, Urbana, Ill.

THIRD INTERNATIONAL CONFERENCE ON MEDICAL ELECTRONICS

The Electronics and Communications Section of the Institution of Electrical Engineers in association with the International Federation for Medical Electronics is organizing the Third International Conference on Medical Electronics which will be held at Olympia, London, England, 21-27 July, 1960. The Conference will include an equipment exhibit.

Further information can be obtained from the Secretary, the Institution of Electrical Engineers, Savoy Place, London, W.C. 2, or from Dr. Lee B. Lusted, Dept. of Radiology, University of Rochester School of Medicine, Rochester 20, N.Y.

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1958 M. B. Visscher, Chairman; W. F. Hamilton, Philip Bard

(Dr. Visscher resigned in January, 1959 and Dr. Bard assumed temporary chairmanship)

1959 Philip Bard, Chairman; W. F. Hamilton, Hermann Rahn

1960 Philip Bard, Chairman; Hermann Rahn, H. S. Mayerson

THE GROWTH OF NEUROPHYSIOLOGY*

ALEXANDER FORBES

I assume that nearly everyone here knows what the nervous system is. But since I heard a supposedly educated man utter a remark which implied that the nervous system pertained only to fidgets and jitters and hysterics and that sort of failing, I think it's just as well to state briefly what the nervous system really is, although most of you know it better than I do. The nervous system comprises the eyes, ears, all other organs of sensation, the brain which receives these sensory impressions, stores them as memories, evaluates them, generalizes, mediates all reasoning and decisions, initiates motion and all other actions, sends messages to the muscles by which we work, struggle and progress. In other words, it's the group of master tissues that regulate our lives and behavior, and above all that differentiate us humans from what we are pleased to call the lower animals.

I once mentioned to a clinician that I thought the medulla, at the base of the brain, which contains the vital centers maintaining respiration and regulating blood pressure, was the most important part of the body from the point of view of maintaining life. He answered, "Oh, no! The arterial tree is the most important." I think his reply was based on the fact that he, as a doctor, could do something about the arterial tree but couldn't do anything about the medulla. The medulla is rather inaccessible to medical and surgical treatment. Of course we can't live without heart, arteries, blood, lungs or kidneys, but to me the nervous system is the most interesting of all.

Forty years ago, at the meetings of the American Physiological Society, practically no one had anything to say about the nervous system. Today one section is devoted to the nervous system, with crowded sessions, and papers morning and afternoon for four days. Sometimes two simultaneous sessions deal with the nervous system, and the neurophysiologist has a very hard time deciding which sections he wants most to attend. I think this prodigious increase in interest which has occurred in the last forty years is due in part to the fact that neurology and psychiatry are getting on a scientific basis and can do more for suffering patients, and partly due to the explosive development of instrumentation which enables us to pry into the hitherto well-concealed secrets of nerve function. I'll come to the matter of instrumentation a little later.

Professor G. H. Parker, who was a very familiar figure to all who frequented this laboratory twenty, thirty and forty years ago, made some of the most important contributions to the knowledge of the nervous system when he traced its evolution from its primitive beginnings in the coelenterate, sea anemone, to the highly organized arrangements in the vertebrates.

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*Lecture given at the Marine Biological Laboratory, Woods Hole, Mass., July 3, 1959.

Figure 1 is from Parker's book on the elementary nervous system. A shows a primitive sensory neurone from the coelenterate, sea anemone--a very simple sort of nerve structure. B is the sensory neurone of a mollusc, with the skin at the left, the cell body and the end branches at the right. C is the primary sensory neurone of a vertebrate. In that case you have the branching receptor endings in the skin, the cell body off at one side, with a connecting link, the axon of the nerve pathway, continuing in and making a branched connection in the center with other nerve cells. Below are shown corresponding stages in the evolution of motor neurones.

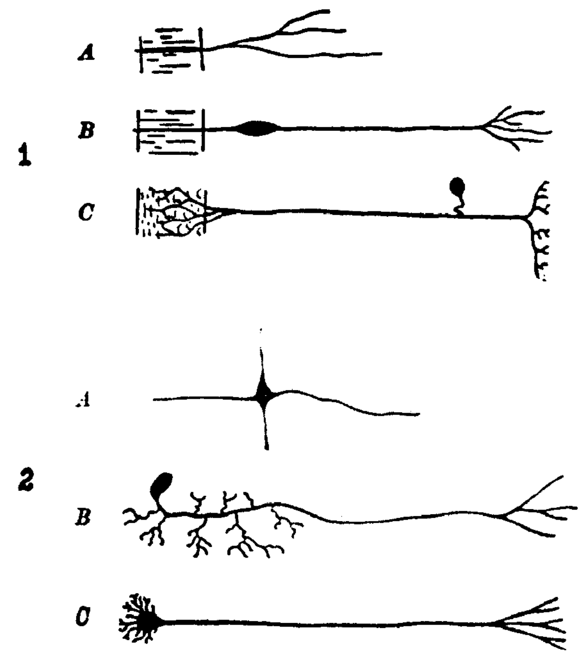

Fig. 1. 1: Stages in the differentiation of sense-cells. A, sensory protoneuron from a coelenterate; B, sensory neuron from a mollusk; C, primary sensory neuron from a vertebrate. In each instance the peripheral end of the cell is toward the left, the central toward the right. 2: Stages in the differentiation of nerve-cells. A, protoneurone from the nerve net of a coelenterate; B, motor neuron of an earthworm; C, primary motor neuron of a vertebrate. In B and C the receptive end of the neuron is toward the left, the discharging end toward the right. (From: Parker, G. H. "The Elementary Nervous System". Philadelphia: Lippincott, pp. 210-211, 1919.)

The earthworm, as you can see, has quite a nervous system. Here is a cell body, with lots of little branches, and the axon and dendrites. Below that is shown the motor neurone of a vertebrate with the dendrites converging on the cell body and the axon continuing to the end branches.

Figure 2 is from Ranson's book, showing in an elementary way the organization of the spinal cord which mediates spinal reflexes in the vertebrate. Here you have an afferent or sensory neurone, with its branches in the skin, coming in through a nerve trunk and going up through the dorsal root with its spinal ganglion. The ganglion cell is off to one side with a little connecting branch. The axon comes in through the white matter of the spinal cord to the gray matter, where it branches and connects with other cell bodies. Below is the motor neurone which carries the message out to the muscle and makes it contract. The cell body is in the gray matter with little dendrites. The axon comes out through the ventral root down to the muscle where it branches and the impulse sets the muscle in motion. Other fibers come in from the other side. Some of them connect with the motor neurones. Others connect through what we call an internuncial neurone, the connecting link. Those are just sample neurones. There are thousands of them in such a section of the cord but just a few are drawn to show the type of structures. More thousands of fibers go up through the white tracts into the brain, and make connections with myriads and myriads of cells up in the brain. This section of the spinal cord illustrates the elementary mechanism of response to stimulus, the reflex arc. Stimuli come in to a central office, which mediates the business and sends out impulses to the muscles to contract. That's

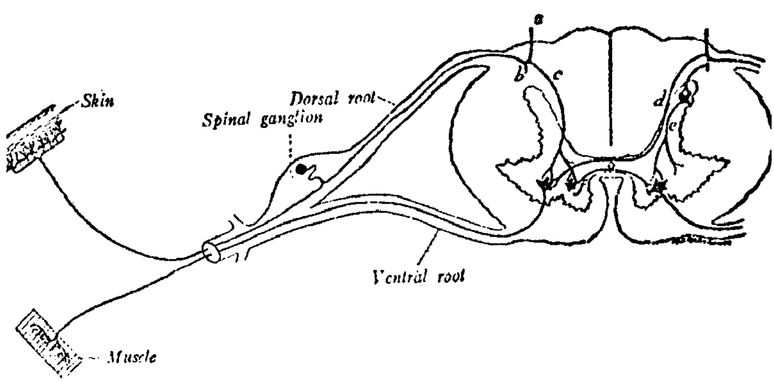

Fig. 2. Diagrammatic section through the spinal cord and a spinal nerve to illustrate the three main classes of neurons in situ. (From: Ranson's "Anatomy of the Nervous System", W. B. Saunders Co.)

the basic mechanism of response to stimulus. But in the vertebrates there are many nervous connections from the spinal cord to the brain where the complexity, especially in apes and man, is so vast that the entire telephone system of a continent is simple by comparison. I don't know how many millions of cells there are in the brain. I think they have been estimated at more than a billion; they are astronomical figures and I have forgotten them.

I think every biologist of course accepts evolution now, but it took a long time to get most people to accept it. Similarities of anatomical structure have been cited more than anything else as evidence, but I think the functional similarities, for example the way in which the nerves work on the same principle from worms all the way up to man, are far more conclusive evidence of evolution than the anatomical similarities.

Now there are three basic approaches to the study of the nervous system: anatomical, chemical and electrical. Transcending these separate approaches is the integration of all three into an overall understanding of how the nervous system works and does its job, which is the basis of behavior. It is in this larger field of integration that Sherrington, 53 years ago, wrote his great work, "The Integrative Action of the Nervous System", the Silliman Lectures at Yale, compiled in book form, which I think is probably the greatest single contribution to the subject that has ever been made. It's a great landmark in the history of understanding of the nervous system. He studied the coordination of reflexes and the way they work together to make an orderly pattern of behavior.

It's rather interesting to note that whereas nearly every paper on neurophysiology today is studded with pictures of electrical responses, there is not one such picture in Sherrington's great classic. He made his masterful contribution on the basis of older methods with little or no reference to electrophysiology. Electrophysiology had been going on for some time but it had not got to the point where it could contribute very much of what Sherrington wanted.

Now as to these three approaches that I mentioned, anatomical, chemical and electrical, I am neither an anatomist nor a chemist. The intricate details of neuroanatomy bewilder me, while the chemistry of nerve passes my comprehension and leaves me in an even denser fog than does the anatomical confusion. I have devoted most of my attention to electrical recording and shall place major emphasis on that approach in this discussion.

There are five classes of excitable tissues all of which give electrical responses when stimulated. The five are: receptor cells (they include cells in the ear and eye and tactile sense organs), nerve, muscle, glands and electric organs which are found in certain fishes in which thousands of cells are arranged in series and in that way are able to develop as much as three hundred volts in some cases. They can give you quite a nasty shock. When they discharge, as they do frequently, they produce quite a disturbance. The chief functions of these organs are apparently aggression and defense. Some have suggested that they may also be used for navigation, just how I don't know. They must be pretty clever to use these electric shocks for navigation. It's a striking thing how similar the time courses of these action potentials (electrical responses) are in their shape; the way they rise quickly to a peak and then decline more slowly. They are especially similar in nerves and muscles.

Electrophysiology, which means the study of electrical responses in tissues, and also the way tissues respond to electrical stimulation, began about 1790 with Galvani's observations on the electric fish, Torpedo, and also in his controversy with Volta over the electrical stimulation of frog's legs. Volta was right in his contention that the nerve responded to stimulation by an external source of current; that is, the external source was what made the frog's legs contract. But Galvani was right when he showed later that a current emanates from a muscle, and that this current can stimulate a nerve. In other words, he demonstrated that there was electricity produced in the excitable tissues. During the 19th century great advances were made in electrophysiology by DuBois-Reymond, Biederman, Bernstein and a number of others but their electrical recording devices were slow and crude compared with what we have today. They were handicapped by using slow, sensitive galvanometers, too slow to record the time course of an action current. If I'm not mistaken, the first really good work in recording the single nerve impulse was by Gotch, Professor at Oxford, about sixty years ago, using a capillary electrometer which is a very quick instrument but it had a lag which made it rather imperfect to use. The invention of the string galvanometer by Einthoven of Holland (reported in 1903) made possible better records but even the string galvanometer, which Einthoven developed, with a string six inches long, was far too slow to show the time relations of the nerve impulse in fast conducting fibers. It was about five or ten times too slow to follow the rapid changes of potential that occur in nerve when it gives an impulse. The cathode ray oscilloscope (you'll see them now in practically every neurophysiological laboratory all over the world more or less) was the first instrument that showed the true time course of the action potential in nerve but in its earliest form it could not be used to photograph a single response. The spot of light on the screen was not bright enough to be photographed and in order to get a picture you had to stimulate the nerve a great many times and have the trace repeat itself over and over again. But even with the cathode ray oscilloscope as it was in the early twenties, Erlanger and Gasser did a monumental survey of the properties of the nerve impulse. In the late twenties, at Harvard, some of us developed a string galvanometer which would follow a frog sciatic nerve action potential with negligible lag. The way we did it was to use a string one centimeter long, of gilded quartz, about one micron in diameter, stretched tight almost to the breaking point and activated by a five-stage vacuum tube amplifier. With that device we were able to get a pretty good record of a frog nerve action potential. The action potential reached its peak in less than half a millisecond and the whole response was over in a millisecond or less. The small preliminary deflection was the stimulus artifact which showed the moment when the stimulus was sent in. We must admit that to get good records with this apparatus we had to stimulate the nerve over and over again and record with a revolving mirror a series of about twenty to thirty responses. But the nerve repeated its performance so accurately that you could get nice clean curves. This type of record is what we call monophasic recording, that is, one electrode was placed on the active part of the nerve; the other electrode on a crushed or inactive part of the nerve where the impulse was blocked, so you would only get the excursion going one way. The curve rose quite quickly to a maximum and then declined rather more slowly. That's characteristic of almost all action potentials in most excitable tissues. At a lower speed of the revolving mirror we could record the single action potential but it did not show the time relations as well.

The improved cathode ray oscilloscopes have made that instrument obsolete because they have got them now so that you can easily take a record of a single action potential.

Although the curves of potential against time in various tissues are similar in shape the time involved differs greatly. Nerve is the quickest, electric organ nearly as quick, skeletal muscle slower, and gland cells very much slower. Figure 3 is a record we took recently of the action potential of the sweat glands on the palm of the hand. The subject had one electrode on the hand, rich in sweat glands, and the other electrode up on the forearm. A series of provocative words were spoken. These responses are not very different in shape from

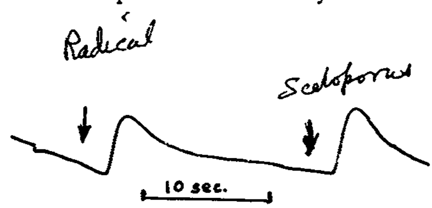

Fig. 3. Action potentials of sweat glands recorded from the palm of the hand in response to word tests.

the action potential in nerve but you notice that the time scale is enormously different. The latency to the spoken word is about two to three seconds. I might explain that the subject had been doing some experiments with the spiny tree lizard, Sceloporous, and that word apparently evoked something of an emotional response. The response to "radical" might be taken to indicate that the subject was either a hide-bound conservative or a radical with a guilty conscience. This record was taken with an oscilloscope, with direct current recording, an extremely convenient instrument for recording slow responses like this and even quite fast responses. It can't follow the action potential of a nerve, but it can follow the action potential of a sweat gland perfectly.

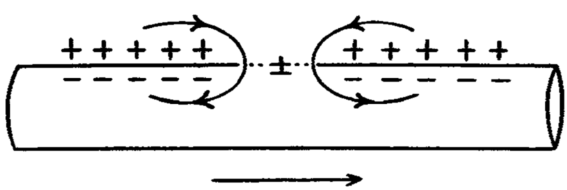

Fig. 4. Diagram to illustrate the membrane theory of conduction in nerve and skeletal muscle.

Now the prevailing membrane theory of conduction is based on many, many observations of nerves and skeletal muscle in which parallel fibers are accessible to the application of electrodes. Figure 4 is an illustration of the principle of the membrane theory. It represents a fiber of nerve or muscle. As far as conduction is concerned, they work on essentially the same principle. Measurements made by placing an electrode inside the giant squid axon connected with one outside show that the outside of the nerve is positive with respect to the inside. When you stimulate the nerve with a blow which damages it, or an electric current, you get a sort of breakdown of this polarized membrane or at least an increase in the permeability to certain ions which has been shown in the squid nerve to be correlated with a great decrease in resistance, so that you are getting an approximation to a short circuit between this battery of charges in the membrane. The result is that the current flows from the positive outside membrane through the active region back to the inside. The stimulus sets up a current and that current in turn excites the next region and a progressive wave of depolarization goes shooting down the nerve. That seems to be essentially what happens when an impulse traverses the nerve or a similar propagated disturbance traverses the skeletal muscle fiber. This is a crude representation of it. There is a lot more to it than that but if I tried to go into all the details I would never get through. The activated point on a muscle or nerve becomes relatively permeable and negative with respect to the inactive region. Now if you put two recording electrodes on the nerve you'll get one negative change when the impulse passes the first electrode and the current reverses as the impulse passes the other electrode. That gives a diphasic record. But if you crush the nerve at a point short of the second electrode, then you get the monophasic record.

A great revolution occurred back in the years from 1912 to 1915 with the establishment of the All-or-None Law for nerve and skeletal muscle. Long ago Dr. Bowditch of the Harvard Medical School demonstrated that the heart contraction was an All-or-None affair, that is, that it contracted or didn't contract and there was no gradation in the intensity of contraction when you stimulated a resting heart. Gotch, with his capillary electrometer recording the form of the electrical response of nerve, furnished presumptive evidence which led him to suppose that the nerve also obeyed the All-or-None Law. Then Lucas with a very ingenious method showed that the contraction of skeletal muscle in the individual fiber was also All-or-None. The reason why you get graded size of contraction as you increase the strength of stimulus is that you get more and more fibers involved but each fiber contracts or doesn't contract; it is an All-or-None response. Pratt, in this country, repeated the experiment with a more refined method and brought even more striking evidence to support Lucas. Lucas also made a very thorough analysis of what went on when you excite a nerve or muscle. He showed that when an electric stimulus is applied to a nerve it first evokes a local excitatory process, as he called it, not an impulse but a process which is presumably a concentration of effective ions at a critical point in the membrane. When this local process reaches a sufficient magnitude it immediately initiates a nerve impulse which sweeps rapidly along the fiber making it refractory to further stimulation for a brief but measurable time. From this fact Adrian argued, and I think his argument is irrefutable, that the All-or-None Law must apply to the nerve impulse, for the refractory period would prevent any further response until the tissue recovers from the refractory phase. As soon as the local excitatory process reaches a critical value the impulse starts and sweeps down the tissue and leaves it refractory. Therefore, it doesn't make any difference how much stronger current you use you can't get it to react again until it recovers from the refractory period. Adrian also showed experimentally that if a nerve impulse is passed through a narcotizing chamber where you have a narcotized region (alcohol vapor for example) the impulse is decreased in the chamber. But when it emerges into the region where it is not narcotized it jumps back to full size. The moral of Adrian's argument and all this evidence is that the energy of the impulse comes not from the stimulus but from the nerve itself. That puts the nerve impulse in the category of an explosion rather than that of a transient current in an inert conductor. Electrical engineers find it very hard to believe that a nerve is not conducting just like a telephone wire. But the evidence shows that the energy comes from the fiber and the stimulus merely triggers it off. To take an analogy, if you talk into a telephone the louder you talk the louder the person at the other end hears your voice. But if you are firing off a gun, it doesn't make any difference how hard you pull the trigger, the explosion has the same energy regardless. In other words, the nerve is delivering the energy it has in it. Just how it recovers from the refractory phase nobody knows but it does. Now the nerve axon, extending as it does often for more than a meter from the microscopic cell body whence it originates, is a highly specialized structure whose function is rapid conduction. The fastest nerve fibers conduct at a rate of about 100 meters per second. That's the speed of a fast airplane. And that means that at a hundred meters per second, if you have a nerve a meter long, in a horse's leg for instance, the impulse gets to the muscle in about a hundredth of a second from the time it started. That's pretty quick. The skeletal muscle is likewise a highly specialized structure whose function is brisk and strong contraction on receipt of the signal carried swiftly by the nerve impulse from a nerve center. It is very interesting to note that although these structures are specialized for wholly different functions they share certain fundamental properties in common. Both can be stimulated by electric current, both have refractory phase and consequently obey the All-or-None Law, both display action potentials, mostly similar in form, though different in duration.

Sherrington in his writings emphasized the problems of the central connection between neurones which he called the synapse. When an afferent nerve fiber comes into a center, branches out and connects with a motor neurone, that point of connection is called the synapse, or connecting link. The word synapse has also been applied to the neuromuscular junction where the nerve excites the muscle fiber and makes it contract. Sherrington showed that whereas the axon simply carries the impulse quickly and without change to its destination, the synaptic system which is the central exchange of our internal telephone system is subject to delay, fatigue, summation, after-discharge and inhibition -- all sorts of modifications, inhibition being suppression of activity. Keith Lucas was a very ingenious pioneer in the analysis of excitation; his brilliant career was cut short in World War I. But shortly before he died he wrote in his book the following comment, "Are we to suppose that the central nervous system uses some process different from that which is the basis of conduction in peripheral nerves, or, is it more probably that the apparent differences rest only on our ignorance of the elementary facts of the conduction process? If we had a fuller knowledge of conduction as it occurs in peripheral nerve, should we not see Inhibition, Summation and After-discharge as the natural and inevitable consequences of that one conduction process working under conditions of varying complexity?" He followed up this question with this precept. He said, "We should inquire first with all care whether the elementary phenomena of conduction, as they are to be seen in the simple motor nerve and muscle, can give a satisfactory basis for the understanding of central phenomena; if they cannot, and in that case only, we shall be forced to postulate some new process peculiar to the central nervous system." This precept of Lucas seemed to me very wise. For years I endeavored to follow it to see how far we could go in explaining the complexities of behavior in nerve centers on the basis of the demonstrated properties of conduction in the axon. I believe this was a sound plan of campaign.

Right here I would like to make an effort to clear up two rather serious misunderstandings which have been prevalent. One, the All-or-None Law has often been misunderstood. It has been taken to mean that the nerve impulse is of invariable magnitude -- either you have a full-sized impulse or nothing. That is not the case. The Law states that the nerve delivers as large an impulse as it can at the moment of stimulation. The size of the impulse can be greatly varied by narcosis or fatigue. It also varies all the way from zero to full size according to the stage of recovery from a previous impulse when the stimulus is applied. This is because of the relative refractory period. Immediately after an impulse has been evoked the refractory period is absolute; no impulse can be evoked. Then comes the relative refractory period when recovery is taking place. At the beginning of this only a very small impulse can be evoked. But the possible size of impulse increases until the nerve can again discharge a full-sized impulse. Thus you have a vast range of possible sizes of nerve impulses which do not in any way conflict with the All-or-None Law. At each point it gives all it can under the circumstances. The other misunderstanding is that I have been severely blamed for insisting on explaining the events in the nerve centers in terms of properties of axon conduction. Actually I was following Lucas' precept, to see how far we could go in the interpretation of central phenomena on that basis. When in later years clear proof was produced to show different types of phenomena in the nerve centers, I was as ready to accept the evidence as anyone. If the forces of evolution developed two types of behavior at the synapse and axon it was all right by me. I have no complaints and no regrets.

Since the early twenties there has been an enormous development of new and penetrating techniques. Notably, the perfection of the cathode ray oscilloscope which can record single sequences of electrical changes in microvolts and microseconds and the microelectrode with a tip less than a micron in diameter -- so small that it can be inserted into the soma of a nerve cell with little or no immediate damage to the cell function. Let me remind you that a microvolt is a millionth of a volt and microsecond a millionth of a second, pretty short time to measure. Supplementing these instrumental techniques have been chemical developments of great importance. A good many years ago we learned that acetylcholine, a powerful stimulant, is highly concentrated in the neuromuscular junction, the point where the nerve ending stimulates the muscle fiber. Some people in spite of that demonstration persisted in the effort to explain neuromuscular transmission on a purely electrical basis. To this Dale replied that it was highly unlikely that nature had established high concentrations of the most powerful known muscle stimulant at the junction of nerve and muscle merely to fool physiologists. For some time the controversy ran between advocates of chemical and electrical transmission at the synapse, both in the nerve centers and at the neuromuscular junction. The combatants were popularly called advocates of "sparks" and "soup". In the neuromyal junction, that is the nerve muscle junction, "soup" won out and acetylcholine is, I believe, clearly established as an essential link in the chain of events. In the nerve centers the picture is more complex. There are many different kinds of synapses and their behavior may not all be the same. It should be noted that every chemical reaction involves some electrical forces, witness the chemical reaction in your flashlight battery. The work of Hodgkin has shown that the electrical potential changes in the nerve fiber are clearly related to the concentration of sodium and potassium ions within and without the membrane. His work has brought us closer to an understanding of nerve function and nerve conduction but no one knows the whole story yet. Hodgkin has done very remarkable work in analyzing all these events about concentration of sodium and potassium, developed the phrase "sodium pump", which somehow restores the condition of a fiber after stimulation.

I should mention here the problem of decremental conduction. Until the twenties it was generally believed that when a nerve was placed in a narcotizing chamber such as Adrian used, where the nerve was subjected to uniform concentration of a narcotic such as alcohol vapor, the impulse underwent a progressive decrement, getting smaller the farther it was conducted through the chamber. The idea was that in a short chanber the impulse might be almost extinguished and then when it emerged it would come up to full size. In a longer chamber it would be extinguished. The idea was a progressive decrease in the size of the impulse. Kato in Japan with a large crew of co-workers, and Davis and I at Harvard independently found reasons to doubt this prevailing belief in decremental conduction. Working in ignorance of each other's projects, Kato and we set up essentially the same experiment and both he and we clearly showed that in a long narcotizing chamber (we had one about 45mm long), with a uniform concentration of alcohol, as long as the narcosis was not deep enough to block the impulse in any of the fibers of the nerve the size of the action potential fell quickly to a reduced magnitude which remained constant through the length of the narcotized region. In other words, recording with the action potential in different points of a long chamber, the size of the potentials would drop down immediately to a lower value and then stay that size till it came to the end and then on emerging come back to the original value. In order to establish that point we had to use a degree of narcosis not sufficient to block any of the fibers. When we did that we established clearly that there was a constant value throughout the chamber. As Adrian had previously shown, when the impulse came into the unnarcotized region the action potential returned to its original size. We also postulated that there must be a transitional decrement where the full-sized action potential exerts some effect as the impulse enters the narcotized region. That is, it seemed to us inconceivable that the impulse should drop instantly to the reduced value, because the action potential is bound to exert some effect on the fiber as it enters the chamber; so we assumed that there is a transitional decrement and a transitional return on emergence. But our experiments showed that this transitional decrement under the conditions of our experiment was over in less than seven millimeters from the entrance to the narcotizing chamber. Lorente de No has just this year reported evidence (National Academy Proceedings, April 1959) indicating that when the narcosis is deep enough to block all the fibers in the nerve within the narcotizing chamber, decrement can be shown within the first few millimeters of narcosis. Both Davis and I have read his paper but have not had the opportunity to study his evidence exhaustively. It still seems to be possible that the decrement he describes may not be essentially different from the transitional decrement that we postulated as the inevitable consequence of the membrane theory of conduction. The problem posed by Lorente de No's experiments is extremely complex and it is premature to pass final judgment.

Turning from decrement, Eccles, Fatt, Lloyd, Bishop and Grundfest have all produced a vast amount of significant information about what goes on in the synapses, dendrites and somata in the central nervous system. There is so much more of this information than I have been able to assimilate that I could not, even if there were time to do so, give an adequate picture of their results. I can only touch on a few of the salient points. Bishop has emphasized the fact that the All-or-None type of response is the exception rather than the rule in the nervous system, being limited to the axons, that is, the nerve trunks and probably also the soma--the cell body of the neurone. Elsewhere, graded activity prevails, activity that is graded in intensity according to the intensity of the stimulating effect. This is a big stride away from the tentative picture that Lucas tried to draw. Bullock has called it a sweeping revolution. Grundfest has given evidence that has led him to conclude that in the dendrites, conduction is decremental and of graded intensity and further that in general the dendritic membrane is not electrically excitable, as in the case of neuromuscular junction, a property which sharply distinguishes these structures from the soma, the axon and the muscle fiber. These three are all directly excited by electric current. But the dendritic membrane according to most of Grundfest's evidence is not electrically excitable. Davis in a recent letter to me says, "I am not ready to generalize that all synapses behave in the same way." He expresses the belief that chemical mediation is the dominant mechanism in the central nervous system but adds, "I do not exclude completely the possibility of direct electrical transmission at some synapses in fast-acting large fiber systems." He is noncommital on that but he leaves the door open.

Apropos of Grundfest's contention that the membrane of the dendrite cannot be directly stimulated by the electric current, I should like to show an example of a muscle which apparently is also electrically inexcitable. On the piles of the wharf across the street, a wharf that has gone years ago, there used to be millions of zooids of bryozoa, Bugula. These animals grow in colonies looking like miniature

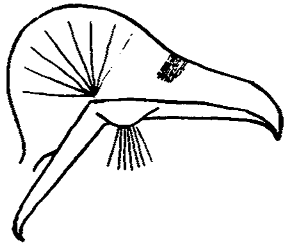

Fig. 5. Diagram showing muscle in the head and sensitive hairs in the angle between the jaws of a "bird's head" on the side of Bugula zooid. ("Biol. Bull." Vol. LXV, p.470, Fig. 2, 1933.)

spruce trees, each colony about an inch long, and each colony containing about five thousand individual zooids. Each zooid is a separate animal in a transparent shell, with ciliated tentacles around the mouth protruding into the sea water. On the side of each zooid is a peculiar structure like the head of an eagle, swaying slowly on a short stalk, snapping its beak about once a minute. Figure 5 is a diagram showing the radiating muscle that operates the jaw and in the angle between the jaws is a little hillock with a tuft of hairs. It has been established by other observers that if you poke those hairs with a fine needle the jaw snaps shut immediately. I was lucky enough once to see a planarian crawling along the stalk, and watched him under the microscope. When he butted his head into the angle of the jaws, the beak snapped shut on his nose. It rather surprised him, I think. I did some experiments with the Bugula, and I found that concentrated salt solution would cause the beak to close and stay closed; dilute alcohol would put the bird's head to sleep with its mouth open. I tried it with the electric shock sent right through the zooid, and that caused a rapid retraction of the ciliated tentacles suddenly drawn very quickly into the shell but apparently had no effect on the bird's head. I watched and watched and sent several shocks in and they never made that muscle contract. Apparently this muscle, which is quick to contract like the skeletal muscle in the vertebrate and can snap the beak shut quickly, is not excitable to the electric current -- according to my observations anyway.

In conclusion, I want to give you a brief glimpse of one of the most intricate and detailed experiments in modern neurophysiology, showing what refined instrumentation can do. Figure 6 is taken from a paper by Fatt, from the "Journal of Neurophysiology." He inserted in the spinal cord of a vertebrate a microelectrode of about 2-3 micra in diameter and took records at various distances below the surface of the cord, then moved the electrode and probed a series of positions. Where he located large responses there was a motor neurone. He didn't penetrate the motor neurone but he went close to it and then on the other side of the figure he moved away further and further to where he didn't get any effect. Now the striking thing is that he has quite an intricate series of events recorded here in the course of a little less than a millisecond, events going on in the cell. By going down with the microelectrode he could map out the effects in different parts of the neurone. His analysis of the results is somewhat controversial and I recently learned that the conclusions he first drew have been questioned by others. I'm not going to try to explain them;

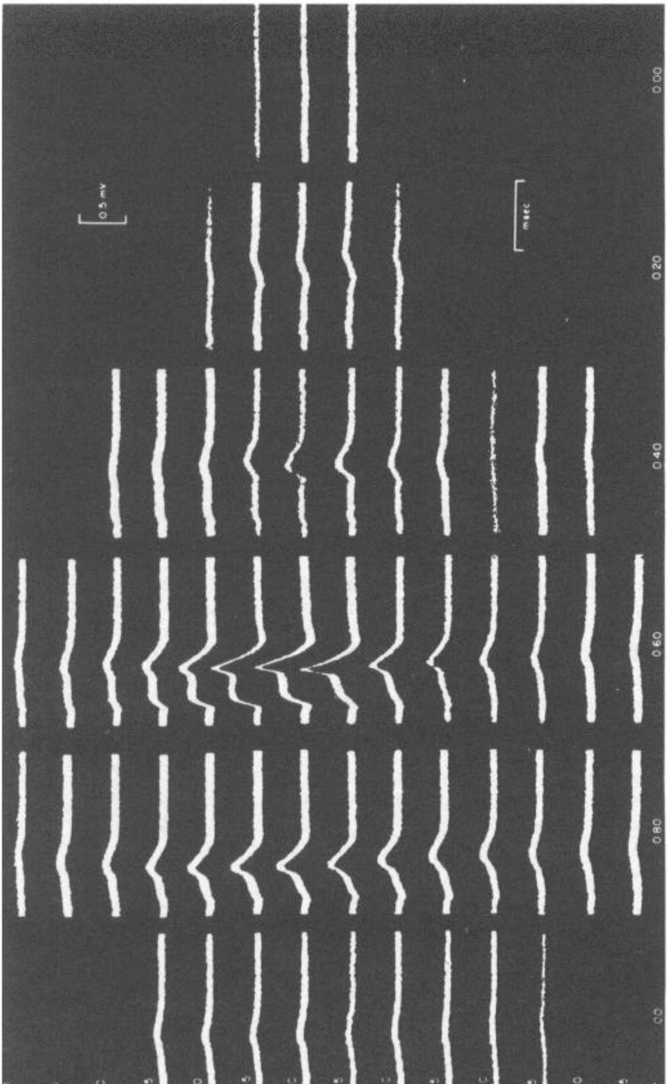

Fig. 6. Record of an experiment by P. Fatt ("J. Neurophysiol." Vol. 20, p. 33, 1957). Extracellular potentials recorded around a single active motoneurone in response to antidromic impulse. Recording stations lay in a single transverse plane. Millimeter scales on left and bottom edges give positional co-ordinates in dorso-ventral and medio-lateral directions respectively.

I'm merely using that as an illustration of the possibilities of analysis that modern refinements of recording techniques have made possible, of the fact that you can get all these delicate variations of very rapid events with the cathode ray oscilloscope by poking right down into the neighborhood of a nerve cell. Fatt is not the only one who has done this sort of thing. Other work of that sort has been done but this is a rather striking example of it.

Hallowell Davis wrote me that Bishop has written a recent article on the relation between nerve fiber size and sensory modality in the "Journal of Nervous and Mental Diseases" (this year, volume 128). I haven't been able to find it yet but Davis speaks of it as a classic which deserves attention in any report on the growth of neurophysiology and so I am mentioning it in case anybody here wants to look it up.

The development of this sort of research in the last twenty years is really explosive, the material coming from many laboratories, so intricate and so detailed that I feel sure no single individual can store all the information inside his cranium. The problem of assimilating it, evaluating it, and building it into an intelligible structure of human knowledge is formidable indeed and I just don't know how the master minds of the future are going to deal with it all.

INTERNATIONAL SYMPOSIUM ON GROWTH; MOLECULE, CELL, AND ORGANISM

World-renowned scientists from England, France, Belgium, Denmark, Canada and the United States will present a symposium on "Growth" at Purdue University, June 16-18, 1960. Such basic subjects as, The Synthesis of Nucleic Acid; Chemical Mechanism in Protein Synthesis; Growth in Tissue Culture; Cellular Differentiation; Enzymes, Vitamins, Steroids, Endocrines, etc; Biological Environments; Changes with Aging; etc. will be discussed.

Further information can be obtained from Dr. M. X. Zarrow, Life Science Building, Purdue University, Lafayette, Ind.

REPORT ON PRESIDENT-ELECT TOUR

J. H. COMROE, JR.

The "tour" of the President-Elect provides a unique opportunity for an officer of the Society to talk individually or with small groups of physiologists -- at all levels, from graduate students to professors -- about the problems of physiology and physiologists. Thus he can learn first hand from those who cannot attend national meetings or who are diffident about raising questions from the floor at our business meetings how the Society can better serve Physiology.

Although the Council is willing to pay the full cost of the tour, the Society incurred no expenses because of the generosity and gracious hospitality of the schools and hosts at each institution. I visited the following schools in February 1960 (and again wish to express my appreciation to each):

City	School	Host
Dallas	Univ. of Texas Med. Sch.	Dr. Robert Lackey
San Antonio	Sch. of Aviation Med.	Gen. Otis Benson
Houston	Baylor Univ. Med. Sch.	Dr. Hebbel Hoff
Houston	Univ. of Texas Dental Sch.	Dr. Edwin Smith
Houston	Rice Institute	Dr. Roy Talmage
Galveston	Univ. of Texas Med. Sch.	Dr. Mason Guest
New Orleans	Louisiana State Univ. Med. Sch.	Dr. Sidney Harris
New Orleans	Tulane Univ. Med. Sch.	Dr. Hymen Mayerson
Jackson	Univ. of Mississippi Med. Sch.	Dr. Arthur Guyton

We discussed a far wider variety of problems than ever come to the attention of the Society at its business meetings. I received many valuable suggestions, all of which I have transmitted to the appropriate group (Council, the Board of Publication Trustees, the Committee on Education or the Federation Board) for further consideration.

Some of the matters which received most attention were:

1. The Federation Meetings. Does the Federation meeting serve its real purpose -- to promote direct communication among scientists working in different aspects of experimental biology? Some physiologists stated frankly that they attended only those scientific sessions in their specific field of interest and did not "cross-over" into other areas of physiology, let alone attend sessions in Biochemistry, Immunology, etc. Most members attended Physiology sessions primarily but "crossed-over" to a limited extent to Pharmacology and Biochemistry.

The majority believe that the Federation meetings are worth while because of the commercial exhibits, and the opportunity to talk to even a limited number of the members of other societies. However, practically all physiologists want facts on the extent of "cross-over'' within Physiology sessions and to the sessions of other Societies. These facts can be obtained in April 1961 by 1) providing name cards which identify members of the six Societies by six colors and placing spotters at the door of each of the 30 meeting rooms to identify the composition of each audience (this would apply to Symposia and Intersociety Sessions as well as to sessions consisting of ten-minute papers), and 2) providing each registrant at the Federation meeting with a ''score card'' and requesting him to enter the session(s) he attended each morning and afternoon; no signature would be required but he would be asked to enter his Society affiliation and special interest.

If there is in fact little or no ''cross-over'', physiologists would like careful reconsideration of the whole concept of the Federation meeting. One plan proposed would schedule three Society meetings (possibly Biochemistry, Immunology and Nutrition) on three days, Intersociety Sessions and Symposia on the next one or two days, followed by the meetings of the other three Societies (Physiology, Pharmacology and Experimental Pathology, preferably with completely integrated programs) on the three succeeding days. A second proposal would dissolve the Federation but set up joint meetings with Biochemistry or Pharmacology on alternate years. Either proposal would permit the Spring meeting to be held in cities other than Chicago or Atlantic City because each would eliminate the present limiting requirement that a convention city must be able to provide 30 rooms for simultaneous meetings of 200-300 people in each. (The questions of regional and quarterly meetings, covering all of physiology or only certain aspects, were also discussed.)

Whether there is sufficient ''cross-over'' to warrant the preservation of the Federation or not, physiologists agree that some decision must be made to limit the number of ten-minute papers presented. This could be by temporary measures (voluntary restrictions on an individual or departmental basis; elimination of ''introduced by'' papers; restriction to three papers per member every five years) which would require new decisions again in 1965, or by more permanent measures which would limit the total number of ten-minute papers, and appoint a program committee to select papers on the basis of abstracts or to select topics for discussion each year.

In any case, members again want facts (including charts of number of papers presented in past years with estimated figures for 1965 and 1970) and then an opportunity to vote on carefully thought out choices. Council might, after consideration of facts obtained at the 1961 Federation meeting, present five proposals (each annotated with pros and cons) to the members by mail -- then re-present those two or three with the most votes until there was a clear majority vote for one proposal.

2. The Fall APS Meeting. Suggestions ranged from beer to baby sitters and included requests for more small group discussion rooms, advance registration, more symposia and more Bowditch-type lectures.

3. APS Journals. Everyone likes THE PHYSIOLOGIST. Many offered suggestions for additional material: 1) advance lists of the

visits of foreign physiologists, 2) advance lists of special conferences and symposia in this country and abroad, 3) lists of departments of physiology which have specialized in unique training programs for Ph.D. candidates or post-doctoral fellows and 4) availability and deadlines for grants for training and research in physiology.

There was more than scattered criticism of the American Journal of Physiology. This included 1) "standards for acceptance are too low", 2) "too many papers are trivial and appear unrelated to anything," and 3) "too many 'partial' papers; would prefer some 'lead' articles of important new work, exempted from usual length limitation." Some members would prefer merging AJP and JAP but arranging and listing articles under major areas of physiology ("sectionalization" but within the same covers). A few believed that the Editorial Board should have better representation of mathematical biology and psychological physiology.

4. Membership. Members wanted further clarification of 1) associate membership, 2) reasons for deferral of certain nominees, 3) the status of Central Americans in the APS -- are they North Americans or South Americans, 4) "evidence of permanent residence in North America." (Note: This last applies only to non-citizens and is intended to discourage nomination of foreign Fellows temporarily working in this country.)

Members suggested that senior physiologists should do something for newly-elected members and graduate students to make them feel at home at our meetings.

5. Dues. I explained to members that, owing to termination of grants and contracts to the APS and consequent loss of "overhead", the Society must find ways to raise approximately $8000 per year. It was gratifying to learn that members expressed a willingness to pay increased dues if other legitimate means of obtaining funds were not to provide the needed funds. However, they did ask for publication of complete financial statements for both the APS and the Journals of the Society.

6. Responsibilities of the APS to its members. Members asked for annual reports on minimal, maximal and mean salaries for physiologists in each range as one way of putting pressure on institutions to pay proper salaries. Physiologists hoped that the APS might in particular do something to obtain better beginning salaries for young physiologists; they pointed out that this is an essential part of any successful recruitment program.

Members want the APS 1) to take up the fight for improving the "status" of biologists and physiologists, 2) to help in anti anti-vivisectionist battles, 3) to recognize properly new subgroups in physiology (psychology, mathematical biology) before they split off from the parent Society and 4) to put pressure on Deans to use NIH "Institutional Grants" for basic science departments rather than for departments of surgery!

SOVIET PHYSIOLOGY AND THE TASKS NEXT IN LINE BEFORE IT*

E. A. ASRATIAN

(Translated by Ivan D. London, Brooklyn College)

Thanks to the classic investigations of those scientific geniuses, Sechenov, Pavlov and Vvedenskii and to the research of their pupils and successors, Russian physiology has won an honored place in world science and enjoys a deserved general recognition. In the light of the historic decisions of the Twenty-First Congress of the Communist Party of the Soviet Union, where the role of science in the successful building of communism is emphasized with special force, the theoretical and practical importance of research work in the field of physiology grows in ever greater degree. It is one of the basic biological sciences called upon to strengthen substantially the scientific foundations of our medicine, agriculture, and pedagogy and to stimulate their future development. This is the reason why an evaluation of the present state of physiology and the elimination of obstacles in its path forward acquire an especial significance now.

Our physiology can and ought actively to advance the successful solution of many pressing problems in theoretical and practical medicine. But in order to do this, it is necessary to take a number of serious measures of scientific and organizational character which would promote the growth of deeper systematic research in the most important areas of physiology. Reference is had, first of all, to those divisions in which we are developing weakly or which have been consigned to oblivion. This is the situation in the physiology of the cardiac-vascular, respiratory, digestive, excretory and endocrine systems, in general and special neurophysiology, in physiology of the receptors, etc. It is necessary to renounce the one-sided approach to the study of the functions of the organism. Meanwhile, in recent times the study of cortical or, at best, nervous regulation of the activity of organs and systems has become sharply predominant among us. Requisite attention is not given to the study of the general and specific laws of their activity, the connection of functional particulars with the finest details of morphological structure, chemical dynamics, and so forth. There is now every opportunity in a comparatively short time to eliminate the lag in the development of a number of the most important divisions of physiology and to guarantee their harmonious development.

The time has come for us to swing over to a many-sided experimental investigation of the most important functions of the organism and of the macro- and microstructure of organs and systems in their

*The author of this informative article is a leading Soviet physiologist and corresponding member of the USSR Academy of Sciences. The article, published shortly before the first meetings of the Ninth All-Union Congress of Physiologists, Biochemists, and Pharmacologists, alerts it to important issues. Source: Meditsinskii Rabotnik (Medical Worker), 45:p.2, June 5, 1959.

different aspects, as we boldly and widely make use of the latest achievements of physics, chemistry, technology, and histology. It is very important to attract specialists in these fields of knowledge into joint study of the complex problems of physiology. Basic research of this kind will advance the successful solution of specific problems in medicine and is also the necessary premise for the future development of biophysics, radiation biology, the physiology of work and sport, and so forth.

It goes without saying that, henceforth, chief attention should be devoted to a deeper systematic study of the functions of the nervous system and the receptors. This corresponds to the glorious traditions of Russian physiology and to the problems of the present, and is singled out due to the importance attached to the neurophysiological direction in research. However, it is necessary to carry through basic changes in the plans, procedures and methods of research work in this field. Our aim should be to keep without exception all divisions of the central nervous system in research-view and not to be occupied with the study of higher nervous activity alone. It is necessary to introduce into the practice of neurophysiological research, boldly and in wide measure, the most delicate and most precise contemporary procedures and methods -- above all, the microelectrophysiological.

If we jointly apply delicate research on the morphological structure and on the chemical dynamics of nerve cells and if at the same time we utilize tested synthetic and analytic methods, we shall be able in the shortest time to overcome our lag in the study of the physiology of the lower and intermediate divisions of the central nervous system. This in its turn will serve as a powerful impetus for a new development in traditional research on the functions of the higher divisions of the central nervous system by means of the classic Pavlovian method of the conditioned reflex. One cannot doubt that our physiologists will handle this difficult and extremely important problem successfully.

It is necessary not only to introduce essential changes in the planning of scientific research, but to review the structure and assigned functions of our research institutes. According to present arrangements in the planning of almost all research institutions in the Soviet Union and the constituent republics, research is being conducted on the physiology of higher nervous activity. People are frequently engaged in this research who do not possess the requisite knowledge and experience in the given field. And this takes place at a time when in the systems of the USSR Academy of Sciences and the USSR Academy of Medical Sciences there are several powerful institutes, specially created to work on problems in the physiology and pathology of higher nervous activity.

Incorrect planning and unwise utilization of scientific personnel have caused great harm to the development of research in many important divisions of physiology. The situation obtaining has not been to the advantage even of physiology of higher nervous activity. The abundant publications on this problem do not serve as a reliable witness of progress in developing the Pavlovian scientific heritage. Only a few of the published research studies are of great value to science and practical application.

It is necessary to manage the planning of research work in the field of physiology in such a way that work in the physiology and pathology of higher nervous activity should be undertaken in the main by certain scientific institutes, possessing the ncessary equipment and highly qualified specialists. This will make it possible for the remaining scientific groups to switch over entirely to work on other divisions of physiological science. The directors of such institutes are usually dissociated from direct experimental work and are swallowed up in administrative-managerial matters. The time cannot be put off for the introduction of clear-cut assignments of functions to the physiollogical research institutes of the Soviet Union and the constituent republics so as to insure that all basic divisions of physiological science will be covered. Simultaneously one will have to break up the cumbrously large institutes into smaller units and to create on the basis of the latter several compact institutes with clearly assigned functions.

Changes must be introduced in the official jurisdiction of physiological institutions. It would be worth while turning over to the USSR Academy of Medical Sciences divisions and laboratories of the clinical type which are now within physiological institutes at present under the jurisdiction of the USSR Academy of Sciences.

Finally, it is time to start thinking about the technical equipment of our physiological institutes and laboratories. We clearly lag behind in this field. In every way we have to look after the development of ideas on the construction of new apparatus and the adoption of the latest technique in physiological laboratories. To this end there ought to be set up a large experimental plant for apparatus-construction (to be associated with the USSR Academy of Sciences or another scientific center). But, without waiting for this, we have to arrange for the serial production of a good many pieces of contemporary apparatus (that is, their production in quantity): bioelectric amplifiers, micromanipulators, microforges, and the like. The adoption of the latest technique pre-supposes improvement in the equipment of the institute workshops.

Capable young scientists should be systematically directed to the best foreign laboratories to master the latest methods.

All these measures will enable the solution of the problems posed by practical demands before the physiological scientists.

THE DEMONSTRATION AS AN ADJUNCT TO THE TEACHING OF PHYSIOLOGY

L. L. LANGLEY

The demonstration, once an important and vigorous adjunct to the teaching of physiology in medical and dental schools has atrophied due to non-use. It has been replaced by the do-it-yourself program of the student laboratory. There is no argument against the advantages of a student carrying out his own experimental work. Nonetheless, it is the thesis of this article that the demonstration still can play a valuable, in fact an irreplaceable, role in the teaching of mammalian physiology. This conclusion is based first, on the fact that the equipment available in the overwhelming majority of student laboratories limits drastically the scope of the student experiments. On the other hand, sufficient equipment, of a more sophisticated nature, exists or can be procured in most physiology departments to permit extensive demonstrations. Secondly, there are experiments which require certain preparations or techniques which make them suitable for demonstration but not for the student laboratory. And finally, the demonstration can be more than an experiment done by the instructor and witnessed by the students. A demonstration should, in essence, be a seminar, an interchange of questions and answers, ideas and criticism replete with blackboard, equipment, and experimental animal.

A demonstration rapidly loses effectiveness as the number of attending students increases. We find that for active participation, for adequate vision of what is being undertaken, no more than 18 students should be present. In view of the fact that medical and dental classes range from 50 students upward another reason for the disuse of demonstrations becomes immediately apparent. Space, faculty, and time are the prerequisites. They are usually not forthcoming.

An attempt has been made in the Department of Physiology of the University of Alabama Medical Center to incorporate regular demonstration periods into the dental physiology course. The class for this course averages 48 students. It is divided into three sections of 16 students per section. Three times per week one section is in the student laboratory, one section is a discussion, and one section in demonstration. This means, of course, that each demonstration must be repeated three times. Three hours are available for each session.

A room measuring about 12 by 17 feet has been set aside as the demonstration room. In this space there is a large wall blackboard. The chairs are arranged on two sides in the shape of an amphitheater on two levels. This permits unobstructed vision by all the students. The remaining floor space is adequate for the demonstration, animal boards, tables and a three channel ink-writing polygraph developed specifically for student use and termed the Physiograph by Hoff, Geddes and Spencer at Baylor (1).

It is not the purpose of this article to outline each demonstration that is presented during the course, but rather to present a few examples to illustrate the value of this technique in teaching. Due to the fact that the nervous system is the first system considered in our course, the initial demonstrations make use of a dual beam oscilloscope to illustrate basic principles of action potentials and the propagation of the impulse.

Figure 1 shows a typical record obtained in a demonstration of muscle physiology. In our student laboratory no means are available for recording action potentials. In this demonstration it is shown that although tetanus is a smooth, sustained contraction, it is maintained by repetitive firing of muscle fibers as exemplified by the individual action potentials. It may also be seen that the electrical activity precedes the mechanical shortening, and that the muscle remains contracted for a considerable period of time after stimulation is ended. Such a record may be easily and rapidly obtained, therefore enough are run off so as to provide each student with one. This aspect of muscle physiology may then be discussed after the student has seen the actual production of the record and has one before him.

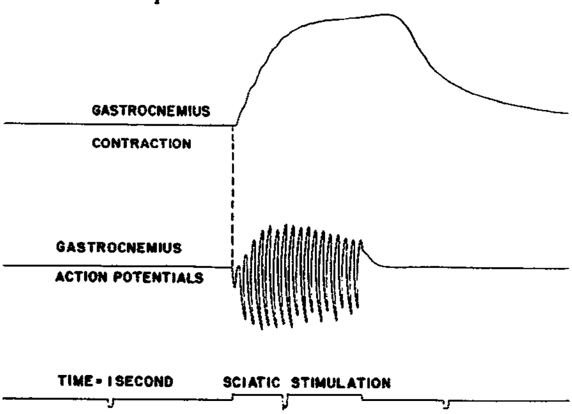

Fig. 1. Muscle action potentials during tetanus.

Beyond question, learning requires active participation. To achieve the greatest student participation during the demonstration, each student is periodically brought into the discussion of the procedure, the record, and the physiological significance of the results. In addition, we have found that greatest interest and best understanding are obtained by having one or two students take over a part of the demonstration. It is quite often possible to pose a problem which the student is asked to solve with the experimental material available in that particular demonstration. This technique evokes more interest, enthusiasm, and academic benefit than any other yet tried.

Figure 2 shows the infrequently emphasized influence of vagal stimulation in reducing the force of myocardial contraction. The student is well aware of the fact that vagal stimulation slows the heart, but that the vagus also decreases the force of contraction is seldom mentioned or seen in laboratory experiments. To obtain the record, the thorax of the dog is opened and the animal placed on artificial respiration. Hooks are placed in the atrial and ventricular myocardium. The hooks are attached by short strings to transducers which convert the force of muscle contraction into a proportional electrical impulse. In the third channel carotid blood pressure is recorded. It is seen that during vagal stimulation not only is there slowing of the heart, but the force of both atrial and ventricular contraction diminishes.

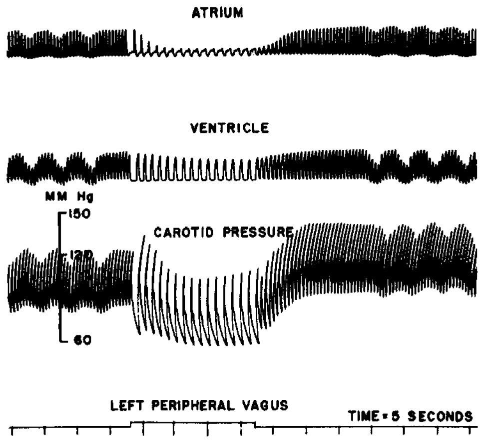

Fig. 2. Reduced force of myocardial contraction in response to vagal stimulation.

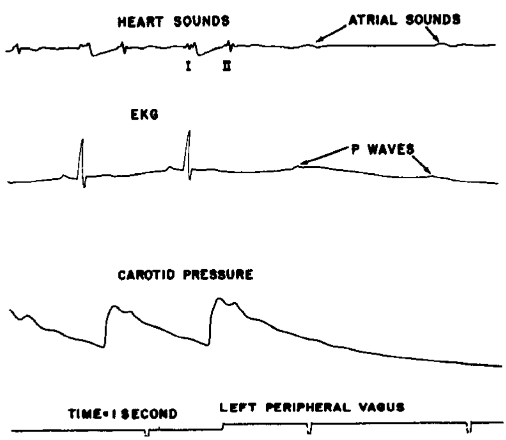

Fig. 3. Atrial sounds.

Figure 3 is a record obtained during a demonstration of cardiac dynamics. In this instance ventricular arrest has been caused by stimulation of the peripheral end of the cut left vagus. The EKG channel shows that despite ventricular arrest the atria continue to contract, and the recording of heart sounds in the first channel demonstrates that atrial contraction alone results in sound. The possible mechanisms for the production of this sound generally evokes stimulating discussion. In the same session it is possible to demonstrate varying degrees of heart block.

In teaching cardiac electrophysiology the problem of the repolarization of the atria inevitably arises. The usual explanation is that the so-called T_p wave occurs during, and is obscured by, the QRS complex. But when one produces ventricular arrest, or heart block, so that P waves are not followed by the QRS complex, the T_p waves are still not seen. The explanation is offered that the amplitude of the T_p wave is too low. It is in just such an atmosphere that a demonstration becomes most provocative. There is.question, there is doubt, there is controversy, and when this is outlined to the class, interest soars for here is an aspect of the subject that is not settled. Here is the opportunity for the student to tread virgin territory. The problem, the possibilities are explained. Then heart block is produced with the EKG recording greatly amplified. Usually this fails to disclose a definite T_p wave. Next, electrodes are sewed to the surface of one atrium and the impulses amplified (fig. 4). Generally there is a large deflection which is associated with the P wave of the normal Lead II EKG. This is assumed to represent atrial depolarization. It is then followed by a much smaller wave, usually in the same direction which we suggest may represent atrial repolarization, that is, the missing T_p wave. The ensuing discussion usually evokes the suggestion that this may be an artifact caused by the conduction of the

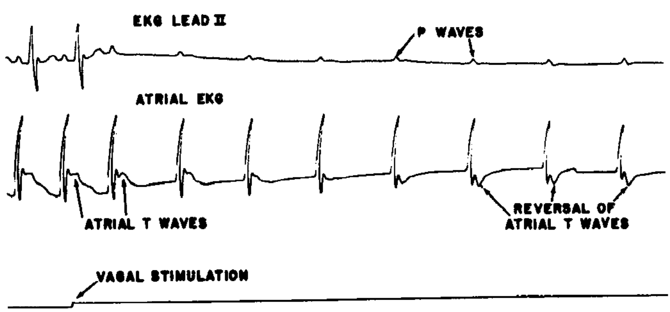

Fig. 4. The atrial T wave.

electrical activity of ventricular contraction back over the moist atrium. Further discussion concerns methods of proving or disproving that possibility. One technique is to cause ventricular arrest by vagal stimulation. If the second wave is but an artifact it should stop with the ventricle. As seen in figure 4, it does not. But, interestingly, its direction undergoes reversal.

The influence of intracranial pressure on arterial blood pressure is dramatically demonstrated in figure 5. To record intracranial pressure in the dog, a hole is drilled in the skull, screw threaded, and a tube screwed in tightly. This is then connected to a pressure transducer. By introducing saline into the cranium the pressure can

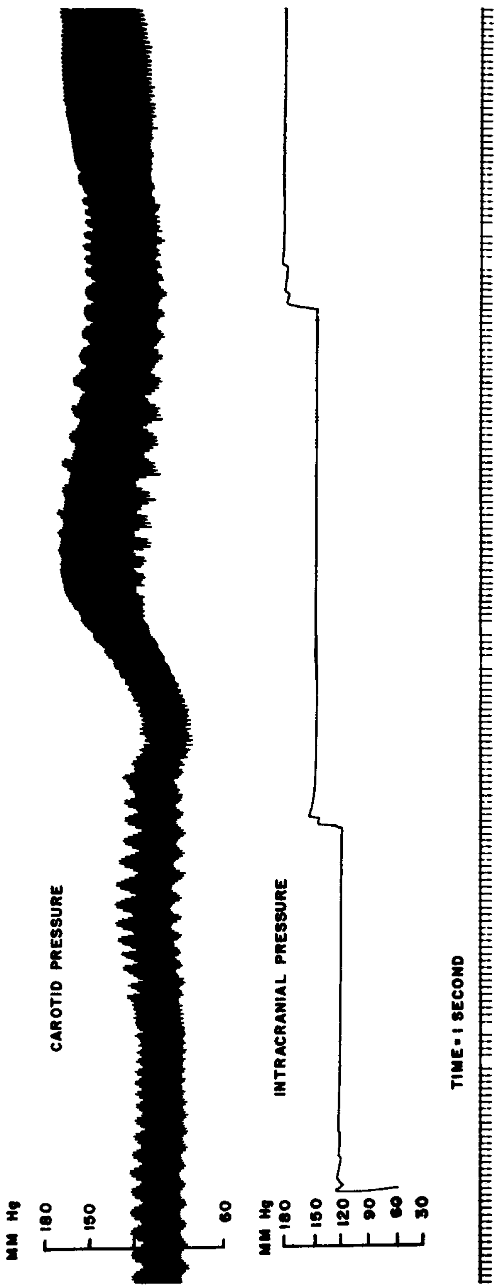

Fig. 5. Influence of intracranial pressure on arterial blood pressure.

be elevated. The influence of elevated intracranial pressure on carotid blood pressure is readily demonstrated and provides an excellent background for the discussion of the responsible mechanisms.

In one of the most stimulating and valuable demonstrations the dog heart is thrown into fibrillation while recording EKG and blood pressure. The change in the EKG and the fall in blood pressure are dramatic. A demonstration of cardiac massage is then given, the effectiveness of which is indicated by the blood pressure recording. Then the heart is defibrillated electrically. Following this the heart is once again put into fibrillation and the students asked to carry out cardiac massage until an adequate blood pressure is obtained. Then they defibrillate the heart. This procedure may be repeated several times.

The concept of oxygen saturation of the arterial blood can be clarified in the demonstration, but not in most student laboratories. An oximeter through which the blood circulates from the carotid artery to the femeral vein is used. Arterial blood pressure and respiratory movements are recorded simultaneously (fig. 6). First, it is seen that the oxygen saturation of the arterial blood in the anesthetized dog is not steady. It fluctuates with respiration. Secondly, it is demonstrated that in this preparation the saturation is less than 100 per cent. Stimulation of the sciatic evokes hyperventilation and, as a result, the oxygen saturation increases. In figure 7 the rapid fall of oxygen saturation following a period of apnea produced by stimulation of the central end of the cut vagus is shown.

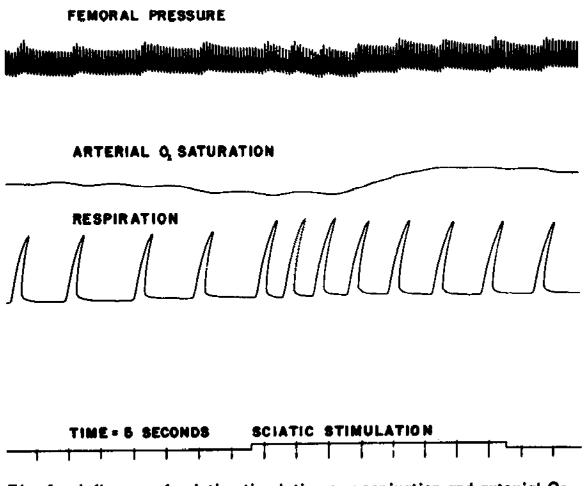

Fig. 6. Influence of sciatic stimulation on respiration and arterial O_2 saturation.

Very few student laboratories have any experiments in renal physiology. In the demonstration a drop transducer is used to record flow of urine from a ureteral catheter. The blood pressure is also recorded. This permits one to show the influence of lowered arterial, and therefore glomerular pressure on urine formation. In figure 8,

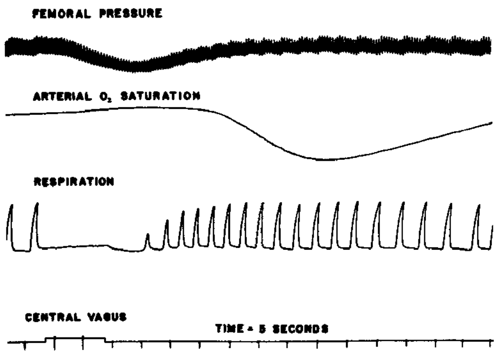

Fig. 7. Influence of central vagal stimulation on respiration and arterial O_2 saturation.

it can be seen that the decrease in arterial pressure is associated with anuria. There then usually follows a period of increased urine formation. This demonstration stimulates a discussion of mechanisms other than the mere reflection of arterial pressure, for example, the possibility of direct vagal influence on the afferent and efferent renal arterioles.

Figure 9 is a record of the type of demonstration that evokes the greatest interest. It is similar to the session on the T_p wave because it enters an area in which there is not general knowledge or agreement. Diuresis is produced by infusion of hypertonic glucose, then the outlet of the ureteral catheter is closed by a valve. A side tube attachment permits the recording of ureteral pressure. This pressure increases and finally plateaus thus giving a rough measure of the effective glomerular filtration pressure. After the plateau is achieved, various procedures may be carried out including the injection of epinephrine, acetylcholine, or vagal stimulation. In figure 9, epinephrine was administered and the expected blood pressure elevation

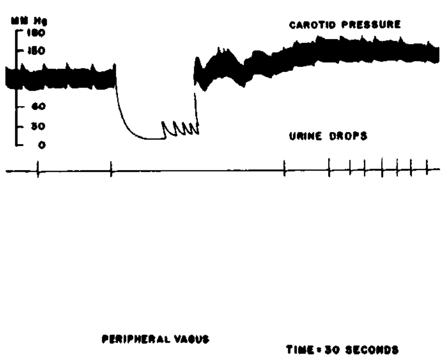

Fig. 8. Influence of lowered blood pressure on urine formation.

occurred. But, simultaneously, ureteral pressure first fell sharply, and then slowly increased, ultimately reaching a level higher than the plateau. Since this demonstration takes place near the end of the semester the students have enough knowledge to enter into a vigorous discussion of the possible mechanisms to account for the observed results. It is this type of discussion that brings the demonstration to its greatest usefulness.

Only a few examples have been given to illustrate the type of record which can be uniformly achieved in the demonstration and which can be easily duplicated so that each student may have a copy. In the course for dental students 12 three-hour demonstrations are given. In addition one session is devoted to an introduction to radio isotope techniques. The student laboratory is equipped with radioisotope equipment but before permitting experiments using these techniques it has been found advisable to demonstrate and discuss the procedures with small groups in the demonstration room.

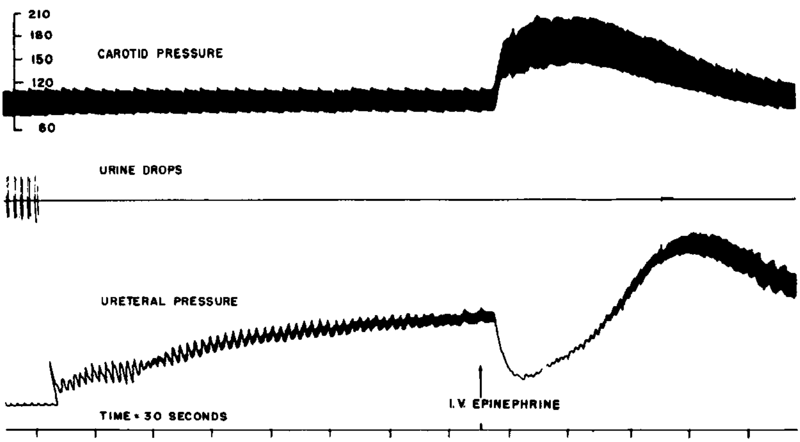

Fig. 9. Influence of epinephrine on glomerular effective filtration pressure.

It is true that many of the experiments used in demonstration could be done by the students if appropriate electronic equipment were available. That is not the case in the great majority of institutions. It would be ideal if such equipment were available but in its absence it is suggested that the demonstration can be an invaluable teaching adjunct. The other objection to the demonstration is shortage of time, space, faculty, and equipment. In this department there is but one room available and enough equipment for but one demonstration at a time. It is for this reason that it has proven impossible, thus far, to use the technique for the medical class which numbers 82 students. It is therefore submitted that the ultimate goal is improvement of student laboratory equipment and experiments, but in the interval, which promises to be prolonged, the demonstration has great usefulness.

REFERENCE

1. Hoff, N. E., L. A. Geddes and W. A. Spencer. "The Physiograph - An Instrument in Teaching Physiology." J. Med. Ed. 32:181, 1957.