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Editor's Page

Publication Costs and Page Charges

Publication costs have been increasing yearly. Printing and paper costs have increased twice in the last year and are going up another 10% on January 1, 1969. Income must be obtained to offset these rising costs. All efforts are being made to cut expenses within the Central Office but this alone cannot offset much of the rising costs which are beyond our control. The Society is not anxious to increase subscription prices.

Subscription income amounts to only about 55% of the total income. Advertising income, although it amounts to very little, will now be taxed so this is not a foreseeable source of additional income. Reprint sales, etc. have amounted to about 16% of the total income. This income will probably decrease due primarily to the advent of the copying machines which nearly every school and organization now have. Incidentally this type of copying of copyrighted material is legally not generally allowable.

Page charges have amounted to about 16% of the total income. The income from these charges in recent years has been able to offset much of the increased production costs. The recent cut in federal research grant funds may have a disastrous effect on scientific publications when the renegotiated grant budgets are finalized. Much research is practically worthless unless it is published. Publication is an essential part of research. Grants have in the past allowed funds for publication costs (page charges, etc.). When renegotiating research grant budgets it is all too easy to pare this item in the grant budget. If research workers do this and state they no longer have funds for page charges other means of subsidizing publication costs must be found if the scientific journals are to continue publishing research results. Pricing subscriptions out of the market is not a good recourse. Researchers should think twice before reducing publication cost allowances in their budgets if they want their research work published.

This is not a matter of crying "wolf." These are facts and scientific journals are already feeling the pinch. Your Society is keeping a close watch on the developing situation and will keep you informed from time to time.

APS MEMBERSHIP STATUS

SEPTEMBER 1968

Active Members	3112
Retired Members	162
Honorary Members	17
Associate Members	254
	<u>3545</u>

DECEASED MEMBERS

The following deaths were reported since the 1968 Spring Meeting.

Bernard V. Alfredson - April '68	V. H. K. Moorhouse - 6/13/68
Louis G. Austin - 2/28/68	Daniel T. Rolfe - 5/26/68
Goran Liljestrand - 1/16/68	G. H. Wang - 6/20/68
Ira A. Manville - 4/29/68	John F. Watson - 4/14/68

NEWLY ELECTED MEMBERS

The following, nominated by the Council, were elected to membership in the American Physiological Society, August 1968 by mail ballot.

FULL MEMBERS

ADOLPH, Alan R.: Res. Assoc., Neurophysiol. Lab., Retina Fndn., Boston, Mass.
ALLISON, Robert D.: Dir., CV Labs, Scott & White Clinic, Temple, Texas
ALLISTON, Charles W.: Assoc. Prof., Dept. Animal Sci., Purdue Univ.
ALPHIN, Reevis S.: Sect. Head, Exptl. Gastroenterol., A. H. Robins Res. Labs.
ASANO, Tomoaki: Asst. Prof., Microbiol., Univ. of Notre Dame
BAINTON, Cedric R.: Asst. Cl. Prof., Anesthesia, Univ. Calif., S. F.
BARLOW, Horace B.: Prof., Sch. Optometry, Univ. Calif., Berkeley
BARNETT, Thomas B.: Prof. Med., Univ. North Carolina
BARTELSTONE, Herbert J.: Assoc. Prof. Pharmacol., Columbia Univ., Coll. P & S
BAUE, Arthur E.: Assoc. Prof. Surg., Univ. of Pennsylvania
BENNETT, Cleaves M.: Assoc. Med., Duke Univ. Med. Ctr.
BESCH, Emerson L.: Assoc. Prof., Dept. Physiol. Sci., Kansas State Univ.
BIEDENBACH, Maria A.: Res. Instr., Dept. Physiol. Biophys., Univ. of Washington
BILLINGS, Charles E.: Asst. Prof. Physiol., Ohio State Univ.
BLACK, Arthur L.: Prof., Dept. Physiol. Sci., Univ. Calif., Davis
BLISS, James Q.: Assoc. Prof. Physiol., McGill Univ.
BORGESE, Thomas A.: Asst. Prof. Biol., Hunter College, N. Y.
BOWERS, Cyril Y.: Assoc. Prof., Dept. Med., Tulane Univ.
BRUSH, Alan H.: Asst. Prof., Biol. Sci Group, Univ. Connecticut
BURGESS, Landry E.: Prof., Dept. Physiol., Meharry Med. College

- BURGESS, Paul R.: Instr. Physiol., Univ. of Utah Coll. Med.
BURLINGTON, Roy F.: Res. Physiologist, Natick Army Labs.
BURTON, Russell R.: Assoc. Spec., Animal Physiol., Univ. of Calif.,
Davis
CALDER, William A., Jr.: Asst. Prof. Zool., Virginia Polytech. Inst.
CANTU, Robert C.: Res. Fellow-Physiol., Dept. Neurosurg., Mass.
Gen. Hosp.
CHALLONER, David R.: Asst. Prof., Dept. Med., Indiana Univ. Med.
Ctr.
CHANDLER, William K.: Assoc. Prof. Physiol., Yale Univ.
CHANG, Thomas M.S.: Asst. Prof. Physiol., McGill Univ.
CHAPMAN, Kent M.: Assoc. Prof. Med. Sci., Brown Univ.
CHIMOSKEY, John E.: US Navy Med. Corp., USN Air Development Ctr.
CLANCY, Richard L.: Asst. Prof. Physiol., The Ohio State Univ.
CLARK, Susanne B.: Assoc. Consult. Physiol., St. Luke's Hosp. Ctr.
CODY, Douglas T.R.: Asst. Prof. Otolaryngol. & Rhinology, Univ. of
Minnesota, Mayo Clinic
COHEN, David H.: Asst. Prof. Physiol., Case Western Reserve Univ.
COLERIDGE, Hazel M.: Asst. Prof. Physiol., N.Y. Medical Coll.
COLERIDGE, John C.G.: Prof. Physiol., New York Medical College
CONSTANTINE, Herbert P.: Assoc. Prof. Biol. Med. Sci., Brown
Univ.
CONTRERA, Joseph F.: Asst. Prof. Zool., Univ. of Maryland
COULSON, Roland A.: Prof. Biochem., Louisiana State Univ.
CUNNINGHAM, Dorothy J.: Asst. Fellow - John B. Pierce Fndn. Lab.
CURTIS, Brian A.: Asst. Prof. Physiol., Tufts Univ.
DAUGHERTY, Robert M., Jr.: Assoc. Prof. Physiol., Michigan State
Univ.
DAVIS, Bernard B.: Asst. Prof. Med., Univ. of Pittsburgh
DAVIS, Terry L.: Instr., Physiol. & Biophys., Univ. of Alabama
DELL, Ralph B.: Asst. Prof. Pediatrics, Columbia Univ.
DeVILLEZ, Edward J.: Asst. Prof. Zoology-Physiol., Miami Univ.
DONALDSON, Virginia H.: Assoc. Prof. Med., Univ. of Cincinnati
DULIN, William E.: Res. Sect. Head, The Upjohn Co., Kalamazoo
EBNER, Ford F.: Asst. Prof. Med. Sci., Brown Univ.
EDISEN, Adele E.U.: Asst. Prof. Biol., St. Mary's Dominican Coll.
EHRlich, Walter: Asst. Prof. Environ. Med., Johns Hopkins Univ.
EICHHOLZ, Alexander: Asst. Prof. Physiol., Rutgers Med. School
EISENBERG, Evan: Adv. Res. Fellow, Biol. Sci., SUNY, Stony Brook
EISENBERG, Robert S.: Assoc. in Physiol., Duke Medical Center
ELEFThERIOU, Basil E.: Asst. Prof. Biol., Kansas State Univ.
ELLIOT, Eric C.: CV Physiol., Walter Reed Army Medical Center
ELLIS, LeGrande C.: Assoc. Prof. Physiol., Utah State Univ.
EMMANUEL, G.: Asst. Prof. Med., SUNY, Downstate Med. Ctr.
EPSTEIN, Stephen E.: Sr. Investigator, Natl. Heart Inst.
FANBURG, Barry L.: Asst. Prof. Med., Tufts Univ.
FENCL, Vladimir: Assoc. in Physiol., Harvard Medical School
FLANAGAN, Joseph M.: Instr., Dept. Med., Harvard Medical School
FOLEY, Charles W.: Assoc. Prof. Animal Sci., Purdue Univ.
FORKER, Edson L.: Asst. Prof. Physiol. & Biophys., Univ. of Iowa
FREEDLAND, Richard A.: Assoc. Prof. Physiol. Sci., Univ. Calif.,
Davis
FRIGYESI, Tamas L.: Asst. Prof. Anat., Albert Einstein Coll. Med.

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 GETTES, Leonard S.: Asst. Prof. Med., Univ. Kentucky
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 GLICK, J. Leslie: Assoc. Cancer Res. Sci., Roswell Park Mem. Inst.
 GOLDMAN, Arthur G.: Assoc. Med., Albert Einstein Coll. Med.
 GOLDMAN, Lawrence: Asst. Prof. Physiol., Univ. of Maryland
 GOLLNICK, Philip D.: Assoc. Prof. Phys. Ed for Men, Washington State Univ.
 GOODMAN, Maxwell W.: Director, Biosci. Res., Westinghouse Corp., Annapolis, Md.
 GRANTHAM, Jaret J.: Sr. Investigator, Natl. Heart Institute
 GREENFIELD, Lazar J.: Asst. Prof. Surg., VA Hosp., Oklahoma City
 GRIMM, Arthur F.: Assoc. Prof. Physiol., Univ. of Illinois, Chicago
 GROSSO, Leonard: Prof. Biol. & Dir. Sci. Div., Long Island Univ.
 GUNN, Chesterfield G.: Prof. Physiol., Univ. Oklahoma Med. Ctr.
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 HARDISON, William G.M.: Instr. Med., Harvard Medical School
 HAZLEWOOD, Carlton F.: Asst. Prof. Physiol., Baylor Univ.
 HEDLEY-WHITE, John: Assoc. Prof., Harvard Medical School
 HERIN, Reginald A.: Assoc. Prof. Physiol., Colorado State Univ.
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 HEUSNER, Alfred A.: Assoc. Prof. Physiol. Sci., Univ. Calif., Davis
 HILL, Richard M.: Assoc. Prof. Physiol. Optics, The Ohio State Univ.
 HO, Ren-jye: Asst. Prof. Physiol., Vanderbilt Univ.
 HOFFMANN, Joan C.: Asst. Prof. Physiol., Univ. Rochester Med. Ctr.
 HORWITZ, Barbara A.: Res. Fellow Physiol., Univ. California, Davis
 HOUSTON, Arthur H.: Assoc. Prof. Biol., Marquette Univ.
 HUBBARD, John I.: Prof. Biol. Sci., Northwestern Univ.
 HUBEL, Kenneth A.: Asst. Prof. Med., Univ. of Iowa Coll. Med.
 HUGHES, Maysie J.: Asst. Prof. Pharmacol., St. Louis Univ.
 JACKSON, Donald C.: Assoc. in Physiol., Univ. of Pennsylvania
 JOHNSON, David F.: Biochemist, Steroid Section, NIAMD, NIH
 KAMM, Donald E.: Asst. Prof. Med., Univ. of Rochester
 KAZEMI, Homayoun: Chief, Pulmonary Unit, Mass. Gen. Hosp.
 KHOURI, Edward M.: Biophys., Cardioresp. Dis., Walter Reed Army Inst. Res.
 KIDDER, George W. III: Asst. Prof. Biol., Wesleyan Univ.
 KLEINZELLER, Arnost: Prof. Physiol., Univ. of Pennsylvania, Grad. Div.
 KNOX, Franklyn G.: Staff Assoc., Natl. Heart Inst., NIH
 KNUTTGEN, Howard G.: Assoc. Prof. Physiol., Boston Univ.
 KONTOS, Hermes A.: Asst. Prof. Med., Med. Coll. of Virginia
 KORECKY, Borivoj: Assoc. Prof. Physiol., Univ. of Ottawa
 KOT, Peter A.: Asst. Prof. Physiol. & Biophys., Georgetown Univ.
 KRIECKHAUS, E.E.: Asst. Prof. Poultry Husb., Univ. Calif., Davis
 KUNZ, Albert L.: Asst. Prof. Physiol., Ohio State Univ.
 KYLSTRA, Johannes A.: Assoc. Prof. Med., Duke Univ. Med. Ctr.
 LAWTON, Irene E.: Instr. Physiol., Loyola Univ. Stritch Sch. Med.
 LEONARD, Edward J.: Sr. Investigator, Natl. Heart Inst., NIH

- LESTER, Roger: Assoc. Prof. Med., Boston Univ. School Med.
LEVINE, O. Robert: Asst. Prof. Pediat., Columbia Univ. Coll. P & S
LISTER, John W.: Res. Assoc., Montefiore Hosp. & Med. Ctr.
LONGMUIR, Ian S.: Prof. Biochem., North Carolina State Univ.
MAGER, Milton: Biochem. & Pharmacol. Lab. Dir., USA Res. Inst.
Environ. Med., Natick
MALETTA, Gabe J.: Health Sci. Admin., Natl. Inst. Child Health &
Human Dev., NIH
MATHEWS, Donald K.: Prof. Phys. Ed., Asst. Prof. Physiol., Ohio
State Univ.
McFARLAND, Willard L.: Physiol., Psychol., Commun. Res. Inst.,
Miami, Fla.
NISHI, Syogoro: Assoc. Prof. Neurophysiol., Stritch Sch. Med., Loyola
Univ.
PALMER, Wilfred H.: Asst. Prof., Cardioresp., McGill Univ.
PECK, William A.: Asst. Prof. Med., Univ. of Rochester
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& Med. Ctr.
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Moffett Field
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Mercy Hosp., Detroit
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YEH, Billy K-J: Fellow in Med., Emory Univ. Medical School

ZEMAN, Frances J.: Asst. Prof. Nutrition, Univ. California, Davis

ABSTRACTS FOR 1969 SPRING MEETING

The Society will continue the practice followed for oral presentation of papers at the 1968 Spring meeting. Accordingly the following system will be used:

The number of papers to be presented orally will be limited to approximately 850. Each abstract will be given a number as it is received in the Central Office. To reduce the number to be presented orally to 850, every n^{th} paper will be excluded. No sponsored abstracts will be accepted. A person's name can appear on only one abstract. An APS regular, retired or honorary member must be one of the authors. Associate members, since they are not members of the Federation, are treated as non-members for the Spring meeting. Abstracts that are excluded by the above mentioned method will be printed in Federation Proceedings but will not appear on the program for oral presentation.

(The total number of abstracts received for the 1968 Spring meeting did not exceed 850, therefore the above rules did not need to be imposed.)

SCIENTIFIC WRITING FOR GRADUATE STUDENTS

A MANUAL ON THE TEACHING OF SCIENTIFIC WRITING

Edited by F. PETER WOODFORD, The Rockefeller University

A Council of Biology Editors Manual Prepared by the CBE Committee on Graduate Training in Scientific Writing

This book has been written because the members of the Council of Biology Editors, like all editors of scientific journals, are acutely aware that many scientists write badly. . . . We asked ourselves why these highly educated and intelligent men and women should express themselves so obscurely, so wordily, and therefore so ineffectually. Although the reasons may be complex, one contributing factor seems clear; few universities provide formal training in scientific writing, and few even encourage their students to develop a rational technique for writing scientific papers through the study of any of the excellent available textbooks.

We believe that this hiatus in university curricula should be remedied, and that formal instruction in scientific writing should form an integral part of a scientist's university training. . . . The considerations involved in this kind of writing. . . necessitate hard thinking about the requirements of scientific proof, the logical development of scientific argument, and precision of scientific expression. For these reasons we believe that the instruction is most effectively given at a late stage of a scientist's training - in graduate school - and that it is best given by a scientist.

. . . the manual is intended primarily for use by the teacher of scientific writing, and is therefore different in purpose from the many textbooks. . . that are meant to be used by the student himself. Nevertheless, sufficiently motivated students will be able to use this manual directly if no instructor is available.

192 pages 6 x 9 cloth \$5.75

The Rockefeller University Press, New York 10021

XXIV INTERNATIONAL CONGRESS OF PHYSIOLOGICAL SCIENCES

August 25-31, 1968 Washington, D. C.

REGISTRATION SUMMARY

*MEMBERS	3, 673
**AFFILIATE MEMBERS	379
PRESS	49
EXHIBITORS	193
	<hr/> 4, 294

*243 not in attendance (82 foreign, 161 U. S. A.), fee paid, publications mailed.

**21 not in attendance

Both the 243 and the 21 were included in the registration count.

DISTRIBUTION OF REGISTRANTS

56 Foreign countries represented.

48 States represented (Montana and S. Dakota not represented).

	<u>MEMBERS</u>	<u>AFFILIATE MEMBERS</u>
Algeria	-	1
Argentina	21	-
Australia	33	7
Belgium	26	2
Bermuda	1	-
Brazil	10	1
Burma	1	-
Canada	158	29
Chili	4	-
Colombia	1	-
Czechoslovakia	47	2
Denmark	17	3
Dominican Republic	2	-
Egypt	1	-
England	158	24
France	100	25
Finland	5	1
Germany	97	5
Ghana	1	-
Guatemala	1	1
Hong Kong	1	-
Hungary	6	-
India	17	1
Iran	3	-
Ireland	7	-
Israel	12	3

	<u>MEMBERS</u>	<u>AFFILIATE MEMBERS</u>
Italy	52	9
Jamaica	3	-
Japan	115	19
Korea	8	-
Lebanon	4	-
Mexico	22	6
Netherlands	38	6
New Zealand	1	-
Norway	14	-
Panama	1	-
Peru	6	-
Philippines	1	-
Poland	11	-
Puerto Rico	3	-
Republic of China	3	-
Romania	6	1
Scotland	21	1
South Africa	3	-
South Vietnam	1	-
Spain	9	1
Sweden	45	6
Switzerland	25	3
Thailand	2	-
Tunisia	1	-
Turkey	5	-
Uganda	1	-
Uruguay	8	1
USSR	46	-
Venezuela	16	-
Yugoslavia	9	-
U. S. A.	<u>2463</u>	<u>221</u>
	3673	379

THE ROLE OF PHYSIOLOGY IN MEDICAL EDUCATION

FOREWORD

Great concern for proper training of the physician of the future together with radically changing medical curricula, prompted the Education Committee of APS to seriously consider the proper place of physiology in the education of a physician. Who should teach it, and under what pedagogic format? A sub-committee consisting of Drs. Braunwald, Carlson, Cooper, Hardy, Mountcastle, Pappenheimer, and Randall, with presidents Brookhart and Forster serving ex-officio, recommended to Council in 1967 that a symposium be organized to examine in depth the results of established and ongoing experiments designed to teach physiology from an updated, more effective and more relevant point of view. Receiving approval, the subcommittee solicited and received instant and enthusiastic cooperation from each of the participants who discussed their considered observations and conclusions in a symposium during the FASEB meetings in Atlantic City, April 18, 1968. The following abstracts represent brief resumes of their thoughtful and carefully documented communications. Full manuscripts will be submitted to the *Journal of Medical Education* for possible full publication.

Although many other equally important aspects of physiology could and should be considered, it was deliberately decided that this symposium should scrutinize only the place of physiology in medical school curricula. Within these narrow confines, reflection upon systems physiology, human engineering, comparative and veterinary physiology, and other closely related views were omitted from consideration. The panel addressed itself solely to this limited purview in the hope that objective and constructive (even though biased) evaluations of current approaches to physiology in medical education might be distilled and refined.

THE TEACHING OF PHYSIOLOGY IN MEDICAL SCHOOL

W. C. RANDALL

Past presidents of the American Physiological Society have warned that physiology, as a distinct and separate discipline, may be disappearing from the medical curriculum. There is growing unrest and uncertainty with the manner in which medical students are being prepared in the basic sciences, including physiology. With increasing frequency, internists and surgeons forcefully express the opinion that they know best what aspects of human physiology should be presented to medical students. In some instances, it would appear that departments have, in fact, abdicated responsibilities for teaching physiology relevant to the specific needs of the future physician. On the other hand, an authoritative source recently stated "in spite of its great relevance to medicine, physiology is now handicapped in its growth in the United States by being too closely shackled to the narrow demands of medical curricula."

In recognition of the information explosion and the impossibility for the medical student to learn any appreciable fraction of the total body

of medical knowledge, many schools are considering radical changes in curriculum. A single mold is no longer considered sufficient for any group of medical students, and it is believed that a number of varying opportunities should exist so that more than one pathway may be followed to a professional career in medicine. Thus, concepts of what the M.D. degree represents, together with opinions as to what disciplines must be mastered in its acquisition, are being subjected to critical reevaluation.

It seems clear that medical physiologists should listen carefully to critics of their role as teachers. As phrased by Dr. Brookhart, physiology in medical education will evolve in adaptation to increasing knowledge and understanding. Should we concern ourselves with the direction of this evolution? The alternative is to allow it to occur, subject to random forces and hope that the outcome will be satisfactory.

Careful evaluation of numerous public pronouncements suggest that innovations in teaching of physiology have been more talked about than tried. What actually has been learned from the few notable departures from classical teaching? Does clear evidence exist for superiority of one approach over others? Although curriculum changes are currently fashionable, are they warranted? There would appear to be a band wagon rolling for "core" teaching. Still, few people seem to agree on what the "core" actually is. While most physiologists enthusiastically acknowledge validity in emphasis upon molecular levels of biology, many retain the conviction that the physician must possess a primary comprehension of organ-system function. Although relatively few now teach from an integrated format, many talk about it. Certainly we would prefer that the physician think that way.

The present symposium elaborates the separate experiences and convictions of six authorities who have actually done something about these specific questions over the past several years. Each represents an authoritative voice speaking from personal experience about a well known departure from classical teaching formats. There has been no attempt to achieve consensus or agreement. No one will be in complete accord with all of the papers, and perhaps with none of them. Probably no single presentation will fit any particular institutional requirements. However, in spite of some disenchantment with the manner in which it is currently offered and with some quarrel as to who should teach it, there is universal agreement that physiology remains the foundation of good medicine. It is our objective here to learn the best way in which to implement teaching of physiology as the purposeful and meaningful discipline in the medical curriculum in each of our individual institutions.

THE PHYSIOLOGIST IN A MODERN MEDICAL CURRICULUM

T. J. REEVES

The overwhelming expansion of new knowledge in every field of science has resulted in a fundamental change in the objectives of modern medical education. A quarter of a century ago, the great majority of medical school graduates went into the practice of medicine with one additional year of formal training or less. Therefore, a fundamental objective of

the curriculum had to be the preparation of its graduates for immediate practice. In 1968 this is impractical within existing definitions of a qualified practitioner of medicine. In many American medical schools the graduate may be regarded as one who is prepared to learn the practice of medicine during an additional period of postdoctoral training and indeed for the rest of his life. These schools also recognize that many of their graduates will seek careers in research, teaching, public health or medical administration and that the objectives of such students must also be taken into account in the design of the curriculum. Thus, a composite statement of objectives of a medical curriculum might be as follows:

1. The impartation of a basic foundation of normal and pathological human biology, upon which the student may efficiently build during all of his professional life.
2. The fostering of an attitude of critical inquiry which will lead to a life of continuing intellectual self renewal.
3. The development of a profound sense of responsibility to his fellow man which should dominate all of his professional and personal life.

Among considerations of modern curricula these elements of training are viewed, not as discreet and autonomous units, but as parts of a continuum, each with sufficient flexibility to allow early and efficient differentiation of the various careers that are to be realized.

By virtue of the rigorous and disciplined nature of his training, the professional physiologist should be in the best position to integrate into a meaningful whole the knowledge that continues to be amassed regarding the function of the parts of the body. If he abdicates his responsibility to direct the teaching of integrated systems physiology, the hope of achieving true excellence in the medical school curriculum will be seriously diminished. Many members of clinical departments are capable of doing excellent physiological research, and add depth and relevance to the teaching of the abnormal physiology which is disease. A systematic comparison of abnormal physiology with normal, in proper degree, not only takes advantage of the intrinsic motivation of the medical student but also sharpens his focus on the regulatory and compensatory mechanisms required to meet the altered conditions of disease. Finally, there is the unstated documentation of the importance of physiology to clinical medicine. It does not appear wise, however, to place the major responsibility of direction and teaching of physiology in the hands of the clinical physiologist. With some notable exceptions, the breadth and depth of his knowledge is sufficiently restricted as to interfere with the most timely integration of the new and the old, of the quantitative and the qualitative. In addition, other assignments of these men frequently preclude their participation at an optimal level of commitment.

The second important role for physiology is provision of opportunity for a meaningful research experience. An attitude of critical inquiry can be fostered in few areas so well as in the research laboratories of

the physiologist. The student should be required to participate in research at an intellectual as well as a physical level. His preceptors must expend a significant amount of time and energy if this experience is to be meaningful.

Finally, physiology can contribute greatly to the attainment of a sense of responsibility by inculcation of a deep and abiding respect and desire for truth. This is learned in the quest for new knowledge through collaborative research with able and dedicated scientists.

In summary, the physiologist has much to offer in the modern medical curriculum. His responsibilities include all of the following:

1. The teaching of a solid core of basic physiological principles relating to the function of major organ systems - the foundation of all medical practice.
2. Impartation of the unique attitudes and skills of the physiologist and the discipline of physiology towards solution of biological problems.
3. Cooperation with other disciplines in the teaching of cellular biology, pathological physiology, physiological chemistry, and physiological biophysics.
4. Provisions of suitable research opportunities for medical undergraduates.

PHYSIOLOGY AS TAUGHT FROM A BIOPHYSICS-ORGAN SYSTEM APPROACH

H. D. PATTON

The problem of how best to teach physiology is secondary to the more general problem of what physiology comprises. The following definitive and distinctive features of physiology as a unique discipline are proposed.

1. Physiology is primarily concerned with mechanisms of the regulation and control of biological systems; the system may be large (e.g. a whole organism) or microscopic (ionic or molecular). The goal of physiology is to explain how the system operating in vivo varies its properties in accordance with varying environmental stresses and demands on the organism. Physiology often needs to study isolated components in order to understand a system, but the ultimate goal is to understand the system and its interrelation with other systems in the intact organism.
2. Physiology limits itself to the study of living cells and systems observed within environmental boundaries consistent with life. It is thus different from biochemistry which properly deals with the chemical nature of isolated products of living cells often examined under conditions far removed from those existing in the intact cell or organism. Physiology views cells and systems

as operating machines, biochemistry views the same structures as biological supply houses.

3. Physiology is the major basic medical science which draws heavily on the University disciplines of physics, physical chemistry and mathematics. Biochemistry, microbiology, pathology, genetics and much of anatomy draw heavily from organic chemistry; hence the trademark "Molecular Biology." Physiology draws on organic chemistry when it is needed, but its major base is in the physical sciences.
4. Because of its basic interest in behavior and control of behavior, physiology overlaps in interest with experimental psychology. This is especially true of neurophysiology but psychological concern with correlates of emotion establish cross connections with cardiovascular, respiratory, gastrointestinal and endocrine physiology.
5. Physiologists use, and often design, instruments to measure variables related to operations of systems. Instrumentation may sometimes be a penultimate but never an ultimate goal of physiology. Hence Bioinstrumentation, Bioengineering, Bioelectronics, etc. are adjuncts to, but not part of Physiology.

Because physiology is primarily concerned with living systems and quantitative study of their control, the teaching of physiology from the standpoint of systems seems essential. The question is only what size of system to focus on for a base. A base in molecular or cellular biology strives to begin at the beginning and synthesize systems by studying their minute components. Since this makes a long story, the student may lose the thread and forget the beginning before the end comes. The organismic base of clinical medicine takes the reverse tack beginning with the whole machine and working backward analytically to explain its behavior. Since some cellular and molecular concepts are required, a course of this sort runs the danger of being bumpy, frequently jumping from whole animal to cell and back again. For these reasons we prefer the organ system as a base. Poised midway between the two extremes with easy access to each, we find it relatively easy to tie the two ends together from the middle.

TEACHING PHYSIOLOGY FROM AN INTEGRATED BASIC SCIENCE-CLINICAL VIEWPOINT

SIDNEY SOLOMON

One approach to teaching physiology is through an integrated basic science-clinical science program. Such a curriculum can be designed to solve certain teaching problems. As might be expected, new problems are raised by this approach. It is the general opinion of the faculty involved in the program that the advantages outweigh the disadvantages.

When the University of New Mexico School of Medicine was formed

five years ago, the faculty was small, with the three men in Physiology constituting the largest single basic science department. The problem existed of producing a teaching program which would not excessively burden the faculty so that time for research could still be allowed. To provide an adequate teaching program and adequate research time, it was decided to institute an integrated approach to teaching and thereby eliminate some repetition which was considered excessively redundant. It was also decided to have each faculty member teach in his area of interest and competence. In this way the integrated program of teaching physiology from a basic science-clinical viewpoint originated.

One factor contributed in a major way toward teaching physiology with somewhat of an orientation toward clinical problems. It was decided that medical students would have contact with patients throughout their training. This part of the program in the first two years is designated Clinical Science. During the time when organ physiology is being covered in Clinical Science, it is obvious that a useful mechanism is provided for relating basic science content to clinical problems.

With respect to the way content is presented, these points are to be noted: 1) During this time of instruction, students have contact with members of different departments. 2) For the most part, the instructors are presenting material about which they are somewhat expert, rather than material which might fall to their lot when taught by discipline. 3) The content which is classified as physiology is essentially the same as might be expected in any physiology course independent of the way it is to be presented. 4) The clinical science and basic science of the program are related.

Teaching in the Department of Physiology is designed to pursue three objectives: 1) to provide an awareness and an opportunity to learn the basic physiological information prerequisite to becoming a physician; 2) to provide an opportunity for developing a critical attitude in reading scientific literature; 3) to provide for the development of an appreciation of meaning and limitations of experimental procedures. The didactic presentations are designed to meet the first objective. A part of the program designated "project time" is designed to meet the latter two objectives. As soon as the students are introduced to physiology teaching, each laboratory group selects a topic in physiology to be explored in depth. The members read extensively on that topic and design an experiment aimed at answering a question which has been raised through the reading. To obtain guidance, to learn criticism and to provide for evaluation of student progress each lab group meets with an instructor for at least one hour a week, with the instructor acting as a tutor. The final phase involves performing the experiment and writing a short paper to be presented orally at a class session.

With any curriculum, one would want to know what success has been obtained and what failures have resulted. Unfortunately, there do not seem to be any objective methods for making such an evaluation. The points which can be made represent the subjective consensus of our faculty. As strengths, one can list the following: 1) The faculty seems to enjoy teaching in this program. 2) The close association of faculty

of like interests has enhanced research activities by making it easier for them to get together on cooperative projects. 3) Unnecessary repetition has been reduced. 4) The immediate application of basic science content to clinical problems and its presentation by clinical faculty has had a positive effect on student attitudes. In the four classes which we have had, no student has asked, "What do we have to know this for?" In general, the students want to learn, even those topics which many medical students considered physiological esoterica. 5) The correlated content provides for the student a synthesis of knowledge obtained from different disciplines.

When it comes to disadvantages, the following may be listed: 1) The good student is deprived of making his own synthesis of knowledge from different disciplines, thereby losing some of the "fun" of learning. 2) Although the overall time spent in teaching is no greater than the time spent under conventional approaches, the fraction of a year's time which can be continuously and exclusively devoted to research is less because teaching time is more spread out. 3) Students never really learn what a discipline like physiology is all about unless they manage to spend some time doing research within the department.

For those interested in setting up a teaching program similar to that described, two potential pitfalls should be kept in mind. In any medical school, it is all too easy for the basic scientists to produce a program which is merely "good enough" for the medical students, and one imagines it could be even easier with our program. This was avoided by establishing the program primarily as a graduate program which medical students could attend. In addition, it must be recognized that final responsibility for teaching physiology resides with the Department of Physiology. Whether with an integrated approach or with another kind of approach, final authority for content must also reside with the Department.

THE TEACHING OF PHYSIOLOGY UPON A BASIS IN MOLECULAR PHYSIOLOGY

W. F. H. M. MOMMAERTS

Physiology consists of investigative work at many levels of analysis and synthesis, and the analysis of molecular mechanisms is among these levels. The teaching of physiology should include presentations of molecular physiology when it is scientifically warranted. An example, briefly describing the mechanism of excitation-contraction coupling in muscle, illustrates how interesting material is available and how it can be made an integral part of teaching of more complex functional systems. An appreciation of the control system whereby muscle contraction, elicited by excitation, involves a complex contractile transduction mechanism which may be switched on and off. Much of the indicated functional mechanisms lie entirely within the realm of molecular physiology, and the teaching of such case histories deserve as much attention as that of recognized classical problems. But the subject does not stop here. Variability in the extent and time course of coupling which leads to contraction is the basis for inotropic changes by which the variable con-

tractile strength of the heart is brought about. This in turn is a part of the adaptive properties of that organ. Thus, the example of muscular contraction displays in one sweep the whole range of physiological comprehension, from the molecular to the organic and the regulatory.

A striking feature of the architecture of physiological function is the concentric structure involving many levels of organization, each higher one composed of many coordinated lower ones connected by regulatory interactions. Comprehension of the total, overall pattern of function constitutes physiology and how it should be taught. Molecular level is one among these levels and, being the simplest and in that sense most basic, is one that should not be absent from our teaching. Thus, good teaching of physiology should include: functional processes including elucidation of molecular mechanisms where possible, study of more complex mechanisms at appropriate levels of description and causation, the combination of organic activities into functional systems including the whole body, the instant regulatory control mechanisms that keep these activities in harmony, and finally the slower regulatory connections that effect genetically controlled development from the fertilized ovum through the embryo, juvenile and adult stages, senescence and death.

A CLINICIAN'S VIEW OF PHYSIOLOGIC TRAINING FOR THE FUTURE PHYSICIAN

EUGENE BRAUNWALD

Physiology, the science that seeks fundamental and comprehensive understanding of life processes, is among the broadest of all sciences. Since it is so broad, instructional programs in physiology should be tailored as closely as possible to the particular needs of the students under consideration. Here we are concerned with the role of physiology in the medical school curriculum. Since the objectives of the graduate student planning a career as a professional physiologist and those of the medical student planning a career as a practicing physician differ substantially, so should physiology curricula differ in content. This difference need not, in fact should not, imply a difference in attitude or approach to physiological science, or a difference in the relationship between student and instructor.

Modern physiological research concerns itself with function at the cellular, subcellular, or even molecular levels, while a progressively smaller fraction of effort is being directed to characterization of organ function. It does not follow, however, that a similar distribution of emphasis is desirable in the physiology curriculum for the future physician. In fact, a thorough understanding of normal and abnormal organ and organ system function is central to the science of medicine and should be the major segment of the physiology course.

A major purpose of modern medical education is the creation of a scholarly, scientific physician. Here the course in physiology, perhaps more than any other science, can provide appreciation for precise measurements on intact organisms, consideration for important interactions

between the organism and the measuring techniques, recognition of biological variability, and appropriately critical use of the scientific literature.

What are the most reasonable ways of exposing medical students to the physiological sciences? Consider two points of view: 1) when in the curriculum should physiology be taught, and 2) who should teach it? Division of the curriculum into two pre-clinical years followed by two clinical years is, to me, pedagogically unsound. The entering student is told he must gain comprehension of the various sciences before he is permitted to examine patients. This leads to frustration for the student who may come to look upon fundamental sciences as a hurdle rather than a vital aspect of his training. He must realize that his basic science grounding must be sound if he is to keep pace intellectually with the enormous advances that will occur in the course of his professional career. The temporal separation of clinical from basic sciences tend to channel the future physician into a narrow and parochial attitude. He feels that once he has passed his basic examinations it is permissible for him to concentrate exclusively on clinical problems for the rest of his life.

Rigid distinctions between pre-clinical and clinical training is obsolete and I submit that medical students ought to commence serious clinical work early in their courses with continuing in-depth exposure to the sciences basic to medicine, throughout the entire curriculum, house staff training, and as mature, practicing physicians.

Finally, how may we identify the faculty responsible for teaching physiology to medical students. The school with which I am associated, the University of California at San Diego, will divide the responsibility between graduate school departments of Biology, Biophysics and Bio-engineering on the one hand, and clinical departments, principally Medicine and Neurosciences, on the other. In general, the non-physician scientist directing his attention to a problem, may not be the individual on the medical faculty most qualified and most interested in teaching the future physician those physiological principles underlying important topics such as blood pressure regulation, hemorrhagic shock, muscular exercise, etc. However, members of clinical departments are becoming increasingly concerned with these problems in their own research. Therefore, it does not seem in the best interest of the medical student, the basic scientist concerned with intracellular processes, or the clinical scientist concerned with normal and abnormal organ function to insist that members of the Physiology Department provide all, or even the bulk of instruction. What is important is that scientific standards be high, regardless of whether the physiologist is a member of a Biology Department in a college, a "card-carrying" physiologist in a Physiology Department of a medical school, or a physician with a clinical appointment.

PHYSIOLOGY IN THE EDUCATION OF PHYSICIANS

D. C. TOSTESON

"In the empirical period of medicine, which must doubtless still be greatly prolonged, physiology and therapeutics could advance separately; this cannot be so when medicine becomes scientific. It must then be founded on physiology. Scientific medicine, like other sciences, can be established only by experimental means, that is, by direct and regorous application of reasoning to the facts furnished by observation and experiment." These words by Claude Bernard define the central role of physiology in medicine and the essential goals of any educational program in physiology for students of medicine. In my opinion, this analysis is as valid today as it was a century ago.

The program in medical physiology at Duke University involves an adequate introduction and exposure to the essential core of information early in the curriculum, with a definite reduction in the amount of material which all students are required to take. The time made available by this reduction is used to permit a smaller group of students particularly interested in the discipline to participate independently in learning experiences of their own choosing. The core course in the first year seeks to supply all students with a kind of information to which Bernard alluded in the above quotation. The program in the third and fourth years has a more important though more difficult goal. It encourages students to develop curiosity, perseverance, and skills in learning about relevant aspects of physiology throughout their various careers in the medical sciences. The role of physiology as the integrating discipline of medicine is emphasized. To this end, expression of strong connections with biochemistry, pharmacology, anatomy and engineering on the one hand, and with clinical medicine on the other are delineated. Our stance can be summarized by further quotation from Bernard: "A teacher's role should be limited to clearly showing his pupil the goal that a science sets itself and to pointing out all possible means for reaching it. But a teacher should then leave his pupil free... according to his own nature, to reach his goal, only coming to his aid if he sees that he is going astray. Science goes forward only through new ideas and through creative or original power of thought. In education we must take care that knowledge which should arm the mind does not overwhelm it by its weight, and that rules, intended to support weak parts of the mind, do not atrophy the strong and fertile parts."

THE INTERRELATIONS BETWEEN BLOOD FLOW AND METABOLIC RATE: A GRAPHIC REPRESENTATION

VICTOR E. HALL

Cardiovascular physiology exhibits a number of instances in which the product of two variables yields a third. Among these are: cardiac output times the peripheral resistance gives the mean arterial pressure, the transmural pressure in a vessel times the radius gives at equilibrium the wall tension (Laplace's law), and, the case dealt with in this note, the blood flow times the arteriovenous oxygen difference gives the tissue metabolic rate. All such relations can be graphically represented in the form $y = ax$, in which a is the slope of the line obtained by plotting y against x . Burton (1), for example, has done this in his equilibrium diagrams for blood vessels wherein the abscissae represent vessel radius, the ordinates wall tension, and the slope of a line through the origin, the transmural pressure. It is suggested in this paper that a similar representation of the relation between blood flow and metabolic rate might be useful.

The fundamental equation for the Fick principle relative to oxygen is

$$\dot{V}_{O_2} = (C_{aO_2} - C_{vO_2}) \dot{Q}$$

where \dot{V}_{O_2} is the oxygen consumption rate (ml oxygen per min), C_{aO_2} is the arterial oxygen constant (ml oxygen per 1 blood), C_{vO_2} is the venous oxygen content (ml oxygen per 1 blood), $C_{aO_2} - C_{vO_2}$ is the arteriovenous oxygen difference (ml oxygen per 1 blood) and \dot{Q} is the blood flow (l per min). Rearranging this equation so as to make \dot{V} the independent variable and dropping the subscripts for oxygen, we have

$$\dot{Q} = \frac{1}{C_a - C_v} \dot{V}$$

The quantity $\frac{1}{C_a - C_v}$ represents the blood flow (in liters) required to deliver one ml of oxygen (which we might call the metabolism-specific blood flow).

If for one set of values, \dot{V} be plotted as abscissa, \dot{Q} as ordinate, and the resulting point connected to the origin by a straight line, that line will have the slope $\frac{1}{C_a - C_v}$, as shown in Fig. 1.

Numerical values for the arteriovenous difference can readily be noted by drawing a circle with center at the origin and radius sufficiently great so that all plotted points lie inside its circumference. For any such point, the line drawn through it, and the origin can be produced to intersect this circle. At this point the appropriate calculated values for $C_a - C_v$ may be written along the circumference. In a sense, such a line might be thought of as representing the pointer of a dial indicating $C_a - C_v$ values.

In the same manner any physiological situation in which the blood

entering an organ delivers some or all of a constituent can be represented by a point in the above quadrant. Further, if the organ delivers a substance to the blood for removal, \dot{V} becomes negative and such situations may be represented by points in the left upper quadrant. Again, if clearance of a constituent from the blood is complete, obviously the slope of the line concerned will be $\frac{1}{C_a}$, i.e., the volume of blood required to contain one unit of the constituent.

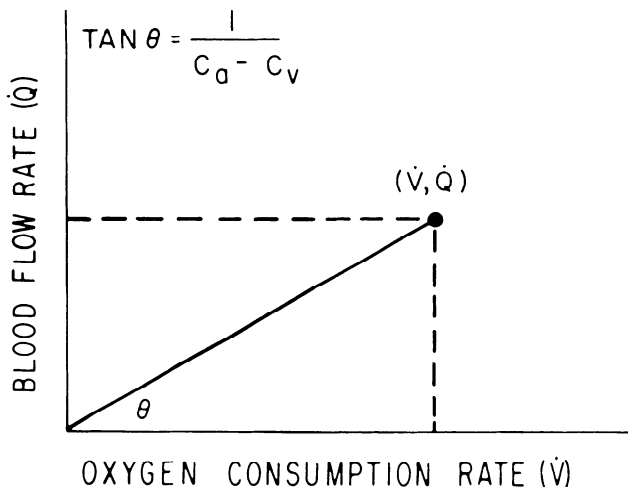


Fig.1. Graphic representation of the relation between blood flow and oxygen consumption. The slope of the regression line is equal to the reciprocal of the arteriovenous oxygen difference.

A simple example of the use of this graphic method is given in Fig. 2. The brain of a human subject is assumed to consume 46 ml oxygen per minute and to have a blood flow of 0.75 l per min. The arteriovenous oxygen difference would be 61 ml per 1 blood.

This approach can be extended to represent additional physiological variables concerned with oxygen transport. Thus, if the physiological situation is such that the arterial blood oxygen content (C_a) can be regarded as constant and known (as is commonly true), then for each $C_a - C_v$ value the venous oxygen content (C_v) can be calculated - and a second concentric circle inscribed outside that for these values.

Again, if also we can legitimately assume that the blood oxygen capacity is constant and known, for each value of C_v there can be calculated the percentage oxygen saturation of the venous hemoglobin. These values can be placed on a third circle. Finally, if we can also take as constant and known the applicable hemoglobin dissociation curve of the venous blood, then for each percentage of venous hemoglobin saturation we can read off the venous PO_2 value at equilibrium, and plot such values on a fourth circle. Such values may be taken as representing

the level of tissue P_{O_2} , a valuable index of the degree of tissue oxygenation.

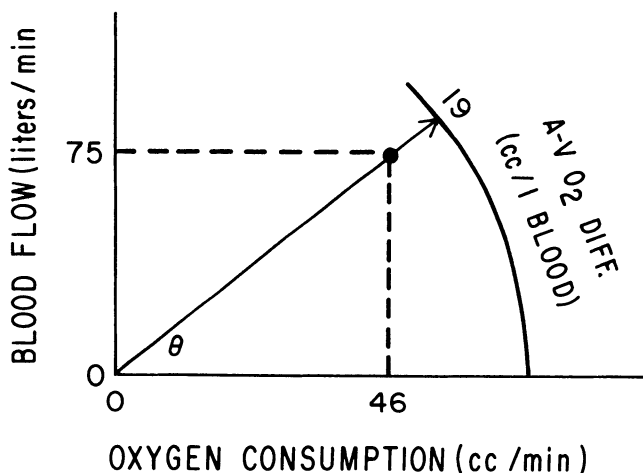


Fig.2. The relation between the blood flow and oxygen consumption of a human brain.

Thus it is possible with such diagrams to see at a glance the status of these physiological values in situations where comparisons are to be made. Two examples are now given.

First, the relation of cardiac output to metabolic rate in exercise is represented in Fig. 3, plotted by Barger et al. (2) from data derived from several sources for man at rest and during exercise at various levels of intensity. This relation is clearly representable by a straight regression line. If we select three points in this line, A for the resting state, B for moderate exercise (oxygen consumption of 1000 ml per min) and C for severe exercise (oxygen consumption of 3000 ml per min), and draw straight lines from the origin through these points to intersect the circles of the diagram, we see immediately and quantitatively that tissue oxygenation, as indicated by a rising arteriovenous oxygen difference, by a fall in venous oxygen content in oxygen saturation, and in venous P_{O_2} , is reduced progressively with increasingly vigorous exercise.

Second, the marked differences in the oxygenation of the various tissues of the body at rest can be represented as in Fig. 4. Here each point represents the oxygen consumption (ml per min) and the blood flow (l per min) of one of six of the major organs of the body, based on the data assembled by Bazett (3). Note that the values of the metabolic and flow rates for each organ are not weight-specific, but are the absolute values. It is interesting to see how the organs with oxygenation below average (skeletal muscle, brain and heart) are those in which blood flow regulation is predominantly metabolic; and those with oxygenation above

average (the liver, skin and kidneys) are those in which nervous regulation of blood flow is predominant.

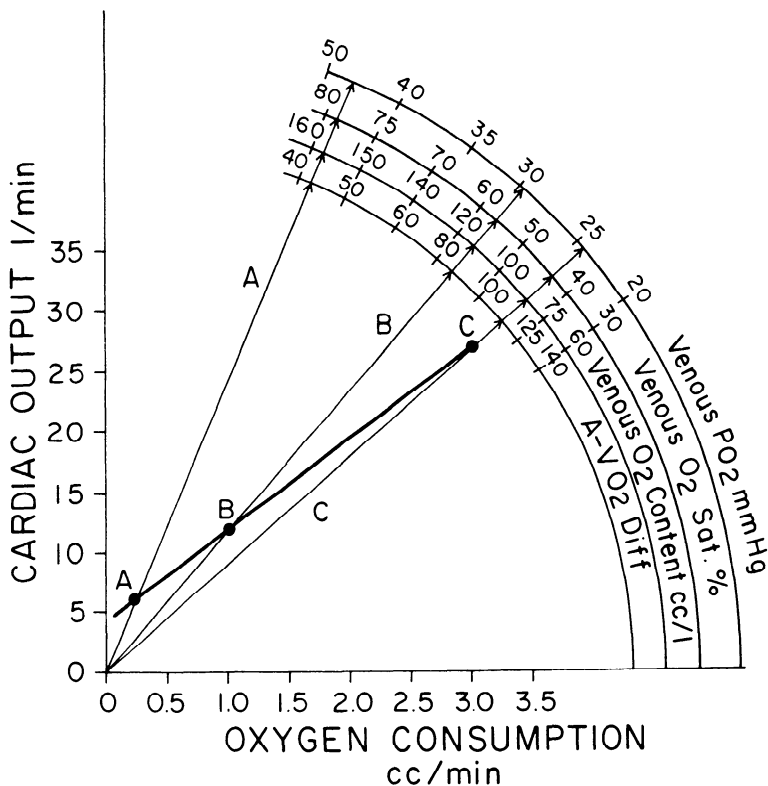


Fig.3. The relation between the blood flow and oxygen consumption of human subjects at rest and in exercise; together with derived measures.

A final word of warning is in order. The estimates of tissue P_{O_2} , venous oxygen saturation and venous oxygen content obtainable from the diagrams described above all rest on assumptions of the constancy of arterial oxygen content, the oxygen capacity of the blood, and the course of the hemoglobin dissociation curve. Thus, it is inapplicable (beyond the representation of the arteriovenous oxygen difference) to such conditions as arterial hypoxemia, anemia, polycythemia, acidosis and alkalosis.

Summary. A graphic method is described whereby, from knowledge of the oxygen consumption and blood flow rates of organs (or of the whole body), there can be represented simultaneously the arteriovenous oxygen difference, and, if certain assumptions are justified, also the venous oxygen content, the venous hemoglobin saturation, and the tissue P_{O_2} . Its value in portraying the changes of these values during exercise, and the distribution of degree of oxygenation of the various organs is shown by several examples.

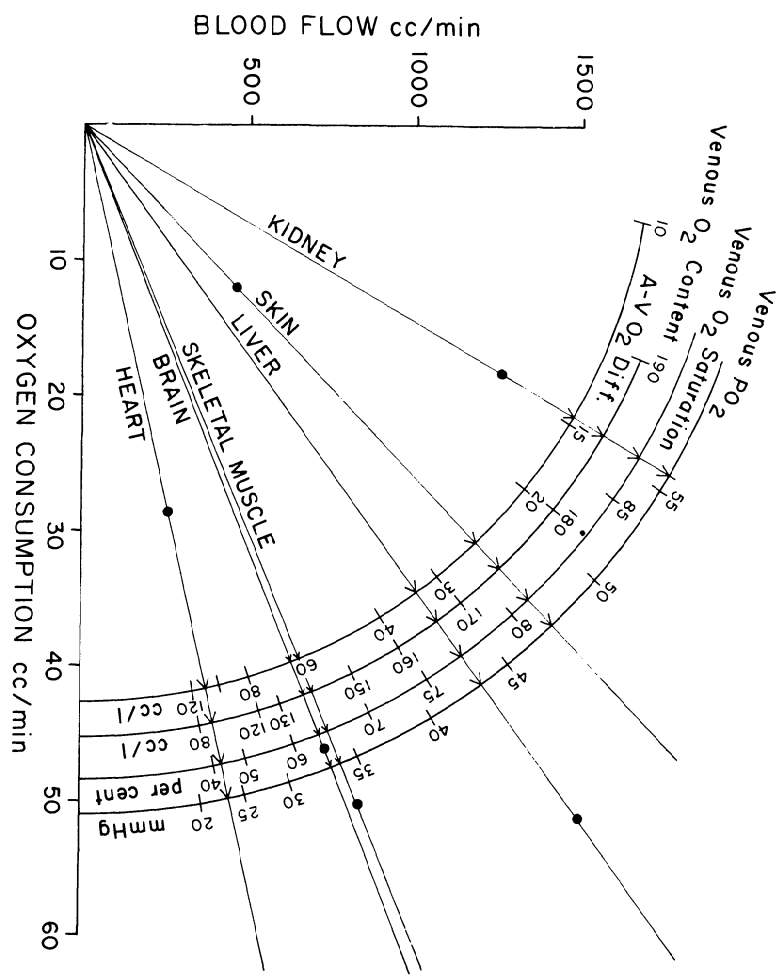


Fig.4. The relation between the blood flow and oxygen consumption of various human organs at rest.

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2. Barger, A. C., V. Richards, J. Metcalfe, and B. Gunther. Am. J. Physiol. 184: 613-623, 1956.
3. Bazett, H. D. In P. Bard, Medical Physiology. 10th Edition, p. 221. St. Louis: Mosby Co.

BACK ISSUES OF AJP

The Central Office of the Society is still trying to obtain a complete set of all APS publications. We have copies of all publications except some older issues of the American Journal of Physiology. The following are needed to complete our set of AJP.

Vols 51 thru 66 (Feb. 1920 thru Nov. 1923)
Vol. 95, number 4
Vol. 96, number 4
Vol. 98, number 3
Vol. 99, number 4

If any person has duplicate copies of the above or has no further use for them the Society would be greatly pleased to have them. Perhaps a retired member would like to contribute these issues to the APS to complete its archival library.

The Society wishes to thank those who have contributed back issues, thus reducing the number of missing issues.

INTERNATIONAL DIABETES FEDERATION

The Seventh International Congress of Diabetes will be held in Buenos Aires August 23-28, 1970. For information write V. G. Foglia, Paraguay 2155, 7th Floor, Buenos Aires, Argentina.

THE ACCENT IS ON READING PAPERS

L. M. N. BACH

To many veteran attenders of Federation and Physiology Society meetings, the pleasure of listening to papers seems increasingly compromised by the difficult task of hearing what is said. No doubt some combination of cerebral arterio- and otosclerosis occasionally hampers perception of neophysiological nuances. Whatever handicaps these may pose, members also often find their understanding of papers made even more difficult when they are read in heavily accented English.

According to most members, one important virtue of our society meetings is the provision for adequate communication of ideas and information by hearing papers presented in the sessions; most also felt that papers should be presented to communicate and to share research results with other scientists (1). When the speaker has a poor command of spoken English, in the opinion of his audience, the results of his investigations are regrettably lost upon those who want and need the information he wishes to offer. Ordinarily, a foreign guest spending a year or two in the laboratory sooner or later gains the understanding of his host and colleagues, especially because they have the advantage of knowing what to listen for. The neophyte audience has no such advantage. Too often we observe a frustrated audience emerging from a session all shaking weary heads and chorusing the now familiar and inevitable question, "Did you understand him?"

Of course the problem varies with successive waves of visiting nationalities. Currently, we see relatively fewer visitors from one country in which English is notorious for its lack of clarity; there appears to be a relative increase in visitors from another large country where a long native history of English usage eases the problem for us somewhat. At least this is suggested by opinions collected from session chairmen at the last Federation meeting. Less than 5% of the papers read at APS sessions were considered difficult to understand because of heavily accented English. As would be expected regional speech problems also arise. At least one speaker presented difficulty because his too rapid speech was so heavily accented with a Southern flavor. We can't solve this type of problem nor can we do much about the heavy accents of some immigrants who have taken U. S. citizenship. But members who sponsor any speaker ought to be more alert to the loss everyone suffers when the invited colleague cannot render English in a manner which is comfortably familiar to our native ears (and auditory gyri).

A recent questionnaire directed to Federation participants elicited 552 responses to the suggestion that poor mastery of English by some foreign speakers is a problem (2). Ideas offered to resolve this problem included: 1) have English-speaking coauthor, sponsor, coworker or Federation staff member read paper, 2) have sponsor certify to author's adequate mastery of English, 3) problem is one for home institution of author, 4) tape presentation in advance and reproduce at meeting, 5) distribute verbatim manuscript or extensive outline prior to presentation, 6) eliminate and read by title only, 7) give in native language

with consecutive translation, 8) tolerate - they tolerate us at International meetings, and 9) project adequate English outline on screen.

Recently, one member followed suggestion 4 and taped his own reading of a paper for his foreign coauthor who subsequently turned on the recorder at his session and, smiling the whole time, silently pointed at the slides as they appeared. While this reveals thoughtfulness for the audience, it also suggests a certain embarrassment for the visitor. Suggestions 1 and 3 appear relevant and feasible. Perhaps every member sponsoring a speaker, foreign or domestic, who reveals less than desirable mastery of spoken English, might invite some local colleagues not familiar with the guest scientist to a seminar or other pre-reading of the paper. These colleagues should be solicited for their private opinion concerning any audibility gap. If the gap appears too wide for early bridging, then the sponsoring member owes it to his fellow members and - with tact - to his guest to provide an "interpreter" for the formal reading. Sponsor and guest could combine forces in the discussion period.

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1. Gerard, R. W. Mirror to Physiology.
2. Clarke, B. L., and McManus, J. F. A. Annual meeting of FASEB: opinions of participants. Federation Proc. 27: 860-869, 1968.

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FUTURE MEETINGS

1969 Spring - Atlantic City, N.J., April 13-18

1969 Fall - Univ. of California at Davis, August 25-29

1970 Spring - Atlantic City, N.J., April 12-17

1970 Fall - Indiana Univ., Bloomington, Ind., August 30-September 3, following AIBS meeting.

1971 Spring - Chicago, Ill., April 12-17

1971 Fall - Univ. of Kansas, Lawrence and Kansas City

1972 Spring - Atlantic City, N.J., April 9-14

BELATED REPLIES FROM SENIOR PHYSIOLOGISTS

Scanning the replies from Senior Physiologists reveals a few such as Richard Whitehead (see below) who would consider a move to a full-time position. D. B. Dill, Chairman of the Committee for Senior Physiologists, has a list of some others who would consider challenging opportunities. Many are available for lectures.

Henry S. Forbes has active roles in the Association of American Indian Affairs and the National Committee on Indian Health. He hopes his friends in APS are "getting interested in control of population."

Abraham Cantarow upon retirement in 1966 became Research Planning Officer in the Office of the Associate Director for Program, the National Cancer Institute. His activities are concerned with evaluating the state of knowledge in certain areas of cancer research and with attempts to arrive at an assessment of specific needs for support of research in these areas. It has been a very rewarding experience, bringing him in contact with what is going on throughout the country and with many old friends and colleagues.

Herbert S. Wells is in good health; the F.M. music system taught him that electronics gives scope to curiosity and inclination to dissect and measure things once limited to physiology. He quotes a recent retiree: "When your wife starts to clean house you got to have some place to go."

Grace Roth continues as Chief of the Vascular Laboratory at the Lovelace Clinic. In 1967 she and 14 men were invited to make a lecture tour to several South American countries.

Gustav Eckstein's excellent health permits him to lecture and write. He is near the end of a long book that touches on his long teaching of physiology and has a thin book in the making on a single bird. He has gathered material for a biography of Pavlov, begun with him just before he died a third of a century ago, and from which he drew a profile for the New Yorker.

Richard Whitehead is in excellent health. He quit smoking 18 years ago: now weight control is a problem. He continues his scientific activities; he also is Executive Secretary to the Colorado Medical Alumni Association and Assistant to the Dean for Alumni Affairs. During a Fulbright professorship in Trinity College, Dublin 1964-65 he became interested in the lives of several famous Irish physicians, more especially Robert James Graves and William Stokes; their original writings are in the library of Trinity College. He has lectured to the History of Medicine Society on their lives and works and is studying the careers of other famous Irish physicians. He would be interested in a challenging opportunity to pursue his interests in respiratory physiology, allergy or cancer chemotherapy or would consider an administrative position in pharmacology or physiology.

Mary Hardy enjoys excellent health and freedom from academic

commitments, the ability to travel, to visit friends at any time of the year or day.

Mary Collett is in fair health. She gains satisfaction from leisure and time to read.

G. H. Ettinger is Director of Medical Planning in the Addiction Research Foundation, Toronto. This is an instrument of the Provincial Government which engages in research, education and treatment. He is associated with professional colleagues in the health and social sciences, including biochemistry, physiology, clinical medicine and teaching. Consequently, he has a student-teacher relationship reminiscent of an academic atmosphere.

George Baitsell at age 82 finds comfort and security in a retirement home.

Harold Chalkley enjoys painting. He has sold some of his creations.

Dayton Edwards remarks: "The items concerning senior physiologists that appeared in 'The Physiologist,' I read with great interest. My official retirement was in 1950 at Cornell but I remained on in minor administrative affairs for eight years during which I prepared a biographical directory of all the living medical graduates, served a year as Acting Dean, and attended a few incidental affairs. Following this, I moved to Virginia and now it's odd jobs about the home, reading the journals and watching the panorama of change. General health is fair, considering the years, vision usable, hearing good and nutritive function adequate. My advice to the young is get going as early as possible. This is the age of youth."

Mrs. Victor Moorhouse reports that her husband is in a nursing home but he enjoys news of his colleagues.

David Rapport finds opportunity to pursue his archeological interests in Mexico and adjacent countries.

Sherburn Cook has a comfortable home in Pacific Grove where he has leisure for studying problems of demography and human ecology.

T. B. Magath is retired and loves it. He remarks that old men "have an important role in giving advice and inconsultative positions, provided their advice is not taken too seriously and followed too precisely. If an institution can afford to give retired men a little space, where they won't get in the way, I would be in favor of it, but not at the expense of those active in the day by day work of the institution."

Eugene Opie, at age 94, has worked in his laboratory at the Rockefeller University since age 68.

Sam Pond, is continuing his scientific activities on a reduced scale at the university of Hartford. Summers are spent camping in Maine.