COMMUNICATION

After reading the article on L. J. Henderson by Dr. Richards in the February issue of THE PHYSIOLOGIST, Dr. A. V. Hill of University College, London, sent the editor a copy of a letter he received from Dr. L. J. Henderson in 1938. Dr. Hill had written Dr. Henderson about a Welsh miner who had been appointed a Commonwealth Fellow and was being assigned to work in philosophy at Harvard. He had given the newly appointed Fellow a letter of introduction to Dr. Henderson.

Fatigue Laboratory,
Morgan Hall,
Harvard University

July 5th, 1938

Dear A. V.,

I have just learned, with very mixed sentiments of regret and hilarity, a story which I now transmit. Your Welsh miner, Russell, turned up one morning at the Fatigue Laboratory. It must have been several months ago. A few days before, a new technician had been hauled over the coals for lack of initiative in getting things going in some of the routine work, and by chance Russell first encountered him. The technician firmly ushered him into one of the rooms, where his metabolism was measured. Next an arterial puncture was made, and then they were about to weigh him when he fainted, smashing a lot of glass apparatus. When he came to, he finally mentioned the fact that he was the bearer of a letter of introduction to me, but, as it happened, I had a lecture that morning and didn't turn up in time to see him. He has never come back, which under the circumstances is quite understandable, for there is no reason why a philosopher should enjoy having his artery punctured. He might well think it an undue interference with personal liberty. Perhaps you will encourage him to try again. I think it safe to say that a second visit will not be dangerous.

This spontaneous appearance of one of the most ancient traditional situations of farce is an excellent case to illustrate Bacon's aphorism that the subtlety of nature is greater many times over than the subtlety of the human understanding . . . or imagination.

I am terribly sorry that Russell should have had this curious experience, though I am bound to say that I think he was strikingly slow in making his business known. He must have formed a high idea of Yankee initiative and enterprise, though perhaps the value of judgement, as the philosophers have it, was not too favorably colored, for arteries are sensitive even in the most detached philosophers.

Yours ever,

L. J. Henderson

SPRING MEETING

The total registered attendance at the Federation meeting was 9121. There were 696 abstracts submitted to the Physiology Society. Some were transferred by request to other society programs and the Physiology Society accepted transfers from other societies. The Physiology program consisted of 637 papers including two symposia and a teaching session. Seven papers were read by title. There were 8 sessions that started with 30-minute tutorial type introductions to the subjects of the session by the chairmen and 6 sessions that permitted time at the end of the sessions for general discussion. The Council invites comments from persons who attended these experimental sessions in order to determine if these types of sessions should be continued at future Spring meetings.

The Society elected Dr. Robert F. Pitts as President-Elect. Dr. Julius H. Comroe was re-elected to Council. He had previously filled the unexpired term of Dr. Katz. Dr. Theodore C. Ruch was elected to Council to fill the unexpired term of Dr. Pitts. Dr. Philip Bard was appointed by Council to fill the expired term of Dr. H. E. Essex on the Board of Publication Trustees. Other appointments to Committees, etc. will be reported in the August issue. All newly elected officers and appointees will take office officially July 1, 1958.

NEWLY ELECTED MEMBERS

The following people, nominated by Council, were elected to full membership. Their titles and addresses were given in the February issue of THE PHYSIOLOGIST:

Alexander, Natalie
Altszuler, Norman
Axelrod, David R.
Barlow, George
Burlington, Harold
Buskirk, Elsworth R.
Carter, Earl T.
Chow, Kao L.
Cook, Sherburne F.
Detweiler, David K.
Durbin, Richard P.
Eik-Nes, Kristen B. D.
Evarts, Edward V.
Fedor, Edward J.
Fritts, Harry W., Jr.
Furman, Robert H.
Goldring, Sidney
Gordon, David B.
Hannon, John P.
Hilton, James G.
Iampietro, Patsy F.
Kessler, Richard H.
Kitzinger, Charlotte
Kramar, Jeno L.
Kupfer, Sherman
Lane, Ardelle C.
Malis, Leonard I.
Merrick, Arthur W.
Mixner, John P.
Palmes, Edward D.
Payne, Loyal C.
Phillips, Hugh J.
Porter, John C.
Pratt, Elmer B.
Reeve, Ernest B.
Rose, John C.
Ross, Benjamin B.
Schreiner, George E.
Soderwall, Arnold L.
Spikes, John D.
Stark, Lawrence
Terzuolo, Carlo A.
Thomas, Garth J.
Thomson, John F.
Towe, Arnold L.
Whitney, John E.
Yu, T'sai-fan

ASSOCIATE MEMBERSHIP APPROVED

The Society unanimously approved the establishment of Associate Membership. Those eligible for Associate Membership are advanced graduate students in physiology at the predoctoral level, teachers of physiology, and investigators in physiology who have not yet had opportunity or time to satisfy the requirements for full membership. Associate members must be permanent residents of North America. They can be proposed, in the normal manner, for full membership at any time they fulfill the requirements.

The procedures for proposing, nominating and electing associate members are the same as those for regular members including sponsorship by two regular members of the Society. Separate application forms for Associate Membership will be supplied by the office of the Executive Secretary. Those requesting membership forms should indicate whether they want Associate Membership or regular membership forms.

The yearly dues for associate members are set at $5.00. They will have the privilege of subscribing to the journals of the Society at the reduced rates for members, and of presenting papers at the Fall meetings of the Society without the necessity of being sponsored by a full member. They will receive THE PHYSIOLOGIST gratis and receive materials mailed to all members. However they are not voting members of APS, are not members of the Federation, and do not have the privilege of presenting papers at the Federation (Spring) meetings without sponsorship of a regular member.

AN INVITATION TO THE FALL MEETING OF THE APS

UNIVERSITY OF WESTERN ONTARIO, LONDON, ONTARIO
September 2-5, 1958

President G. E. Hall and Dean J. B. Collip (both of whom are themselves physiologists) extend a cordial invitation to all members of the Society and their friends to attend the meeting. London is a city with a population of 100,000, in the heart of the farming area of Southwestern Ontario. The meeting will be on the University campus, in rural surroundings on the river Thames, just north of the city limits. The Medical School is three miles away in the city itself.

The refresher course will be on Tuesday afternoon and evening, Sept. 2nd and Wednesday morning, Sept. 3rd. It has been arranged for the Society's Committee on Educational Matters by Dr. Horace Davenport, on the subject of Teaching of Gastrointestinal Physiology. The Scientific Sessions will be from Wednesday noon to early Friday afternoon (Sept. 5th). There will be the annual dinner of the Society, with the address of the retiring President, and the third annual Bowditch lecture given by Dr. Arthur B. Du Bois of the University of Pennsylvania. A "Smoker" is also being arranged.

The local committee regrets that we have accommodations in University and College residences for only about 350. The Hotel London has 300 rooms and there is a large number of excellent motels 3 to 6 miles from the campus. It is hoped that many members may decide to combine attendance at the meeting with a holiday trip by car to the lakes and woods of Ontario. (The Muskoka District in the Precambrian Shield is 150 to 250 miles from London, and Lake Huron resorts are much closer.) London is reached by rail from Buffalo, Toronto and Detroit by the Canadian National and Canadian Pacific Railroads, and St. Thomas, 15 miles south of London, is a division point on the New York Central Railroad. By air, TransCanada Airlines serves London Airport, with connections to Toronto, Windsor, Detroit and Cleveland. U. S. currency is universally accepted in London, but usually at the prevailing discount which, at the moment, is about 2%. Prices for meals are generally lower than in the U. S., in the town, and at the new University Cafeteria on the campus.

The notices, with information and reservation forms are being mailed to members. The deadline for abstracts of 10-minute papers to be given will be June 21st and these will appear in the issue of THE PHYSIOLOGIST reaching members in August.

We are offering "culture" as well as science in an excursion on Friday evening, Sept. 5th, to the Stratford Shakespearian Festival (35 miles from London) for a performance of "Henry IVth, part II," for those who make reservations on the forms provided in the preliminary announcements.

The local committee hopes you will come. and will do their best to make your visit to London enjoyable.

A. C. Burton and J. A. F. Stevenson

ORGANIZATION AND AFFILIATIONS OF THE AMERICAN PHYSIOLOGICAL SOCIETY

The American Physiological Society is an organization of professional physiologists. An application for membership is sponsored by two active members. From the applications received Council makes nominations to the Society. Nominees are elected by a two-thirds majority vote of the members present and voting at a Spring or Fall meeting. The Society is managed by a Council made up of a President, Past President, President-Elect (Secretary of Council) and four Councilors. The terms of the President, President-Elect and Past President are for one year. The President-Elect automatically becomes President after one year and the President automatically becomes Past President after one year of office. Councilors are elected for a term of four years, one retiring each year. Election of officers and councilors takes place at the Spring meeting. No officer or councilor can immediately succeed himself, unless he is filling an unexpired term. Dr. Ray G. Daggs is the Executive Secretary-Treasurer with offices at 9650 Wisconsin Avenue, Washington 14, D. C.

Since the major purpose of the Society is to promote the increase of physiological knowledge and its utilization, one of its most important components is the Board of Publication Trustees. This Board is made up of three Society members appointed by Council. The term of each member is three years. A member may not serve more than two consecutive terms. The Chairman of the Board is designated by Council. He serves as an ex-officio member of Council. The Board is charged with complete responsibility for management and publication of the various Society journals and special publications. It appoints the various Editorial Boards and Editors. Dr. M. O. Lee is Managing Editor of all Society publications. Dr. Daggs acts as Associate Editor for Physiological Reviews and Editor for THE PHYSIOLOGIST.

The Society maintains various standing committees, the members of which are appointed by Council. The present active committees are:

Porter Fellowship Committee: Sets the rules and regulations of the Fellowship and yearly selects a Fellow from among applicants. The funds for the Fellowship are supplied by the Harvard Apparatus Co.

Education Committee: The history and activities of this committee were detailed in an article in the February issue of THE PHYSIOLOGIST, page 39.

Program Advisory Committee: Organizes symposia and special sessions for the Spring meetings. Suggests topics for special sessions.

Committee on Placement of Senior Physiologists: Deals with all matters pertaining to older physiologists who are retired or about to retire. Conducts an informal confidential placement bureau for senior physiologists.

Committee on International Physiology: Represents the APS in all matters pertaining to International Congresses and Unions.

The Council also appoints a Historian.

The Council appoints representatives to various other organizations: AIBS (American Institute of Biological Sciences); AAAS (American Association for the Advancement of Science); NRC (National Research Council of the National Academy of Sciences)—Division of Biology and Agriculture and the Division of Medical Sciences; U. S. National Committee for the IUPS (International Union of Physiological Sciences); ADI (American Documentation Institute).

The IUPS is an organization chartered by ICSU (International Council of Scientific Unions). IUPS has its own constitution and officers and council. It is mainly responsible for International Congresses of Physiological Sciences. It maintains a National Committee in each adhering country. Each National Committee has responsibility for all matters from its particular country dealing with the IUPS. The adhering mechanism of the U. S. National Committee is through the National Academy of Sciences with cognizance of the State Department. The U. S. National Committee is made up of representatives from the American Physiological Society, Society of General Physiologists, American Society for Pharmacology and Experimental

Therapeutics, and a member at large appointed by the National Academy of Sciences.

The American Documentation Institute is a professional society of documentalists that deals with the distribution, storage, retrieval and use of information. The Board of Publication Trustees pays nominal dues to this organization.

The Society pays dues to the Federation of American Societies for Experimental Biology and the American Institute of Biological Sciences, the organizations in which it holds membership.

THE FEDERATION

The FASEB (Federation of American Societies for Experimental Biology), often referred to as The Federation, is an organization of societies, not individuals. These societies are: American Physiological Society; American Society of Biological Chemists; American Society for Pharmacology and Experimental Therapeutics; American Society for Experimental Pathology; American Institute of Nutrition; and American Association of Immunologists. The Federation is managed by a Board made up of the President, Secretary (President-Elect in the case of APS) and the immediate Past President of each of the constituent societies. The Chairman of the Board is furnished for a one-year term by each society in its turn as determined by seniority in the Federation and is the immediate Past President of that society. Dr. Alan Burton of the American Physiological Society is the current Chairman of the Board. Dr. M. O. Lee is the Federation Secretary with offices in the Federation's headquarters at 9650 Wisconsin Avenue, Washington 14, D. C.

The Federation maintains various standing committees, the most important of which is the Secretaries' Committee, made up of the Secretaries of the constituent societies. The Committee has two major responsibilities, that of arranging the Spring meetings and programs and that of acting as the Editorial Board for Federation Proceedings, a quarterly published by the Federation. Dr. Lee is Managing Editor of Federation publications.

The Federation owns and operates Beaumont House, 9650 Wisconsin Avenue, Washington 14, D. C. Space is made available in this building for permanent offices of the constituent societies. At present only the American Physiological Society and the Physiological Society Publications have quarters. The Federation maintains a staff at Beaumont House and offers certain services to constituent societies. It furnishes all members of constituent societies with copies of Federation Proceedings. It maintains a Business Office which offers services to constituent societies and the Board of Publication Trustees of the American Physiological Society. It maintains a Convention Office which is involved primarily with the management and details of the Spring meetings. It will also handle International Congresses of member societies if requested when the Congresses are held in the U. S. The Federation maintains a Placement Service, the function of which is to assist in placing professional personnel in suitable positions. Through a contract with the National Science Foundation the

Federation maintains a division of the National Roster of Scientific and Technical Personnel that deals with the disciplines represented by the member societies.

AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES

The AIBS (American Institute of Biological Sciences) is primarily an organization of biological societies but does have individual memberships as well. The purpose of AIBS is the advancement of biological sciences and their applications to human welfare through agriculture and medicine. The Institute assists its society and individual members in such matters of common concern as can be dealt with most effectively by united action. It cooperates with local, national and international organizations concerned with the biological sciences. It promotes unity and effectiveness of effort among all those who are devoting themselves to the biological sciences and their applications by research, by teaching or by study. It fosters the relations of the biological sciences to other sciences, to the arts and industries, and to the public good.

The American Physiological Society is one of the 16 member societies of AIBS. Individual APS members receive the AIBS Bulletin (published 5 times a year) as one of the services of APS membership in AIBS.

The AIBS is managed by a Governing Board made up of one appointed individual from each member society. The Governing Board selects its own officers. Dr. W. O. Fenn, a Past President of APS, is the current President of AIBS. Dr. Hiden T. Cox is the Executive Director with offices at 2000 P Street, N. W., Washington 6, D. C. The AIBS maintains several active committees, one of the most active of which is the Education Committee.

FIRST BOWDITCH LECTURE*

Role of the Red Blood Corpuscles in the Regulation of Renal Blood Flow and Glomerular Filtration Rate

By John R. Pappenheimer

Career Investigator of the American Heart Association,
Visiting Professor of Physiology, Harvard Medical School

Henry Pickering Bowditch was instrumental in founding—not only the American Physiological Society—but also a delightful summer camp not so very far from here in the Adirondacks. To this camp came distinguished physiologists from many countries — Sir M. Foster, Mosso from Italy, Freud, Gaskell, Waller, Locke — to mention but a few. I like to think that some of the early policies affecting both this Society and its counterpart in England were formulated in the course of these mountain visits. You will recall that Prof. Bowditch was not only on the first editorial board of our journal, but 20 years previously he was on the original editorial board of the English Journal of Physiology.

In spite of the relatively slow means of transportation and communication, there must have been a very close relationship between the physiologists of the old and new worlds. Indeed, modern transportation is in some ways detrimental to close relationships of the kind Bowditch made. When Sir Michael Foster visited Bowditch's camp it took him two days' travel by horse, rail and foot from Boston. Visits were correspondingly prolonged and I suspect that Foster learned more about American physiology from leisurely conversation with Bowditch and other scientific guests at the camp than he would have from a series of rapid visits to widely separated laboratories.

Conversely, when Bowditch went on his periodical excursions to France, Germany or England, he stayed long enough to become fluent in the appropriate language and to form lasting friendships. When in Paris he wrote his notes in French, when in Leipzig he wrote in German.

In browsing through Bowditch's notebooks I came across a poem - written in pencil about 1879 while he was in Paris. The poem has no bearing on anything and I do not even know whether Bowditch was its author. But I will read it nevertheless because it has a nice Victorian flavor and because it shows that our first President was not always quite so austere as he appears in his photographs:-

*THE PHYSIOLOGIST was established after the first Bowditch Lecture. Since the yearly Bowditch Lecture will be published in THE PHYSIOLOGIST it was thought that persons who did not have the privilege of hearing the first Bowditch Lecture, delivered at the 1956 Fall Meeting in Rochester, New York, would like to read it.

Four doctors tackled Johnny Smith
They blistered and they bled him.
With squills and antibilious pills
And Ipecac they fed him.
They bukted up his gastric juice
And tried t'excite his liver
But all in vain, his little soul
Was wafted o'er the River.

This evening I propose to discuss evidence underlying a new theory for renal hemodynamics. Our point of departure is an observation made by F. R. Winton about 1930. Winton found that the blood flow through isolated perfused dog kidneys is relatively independent of the perfusion pressure. An illustration of his finding taken from one of his later experiments is shown in figure 1.

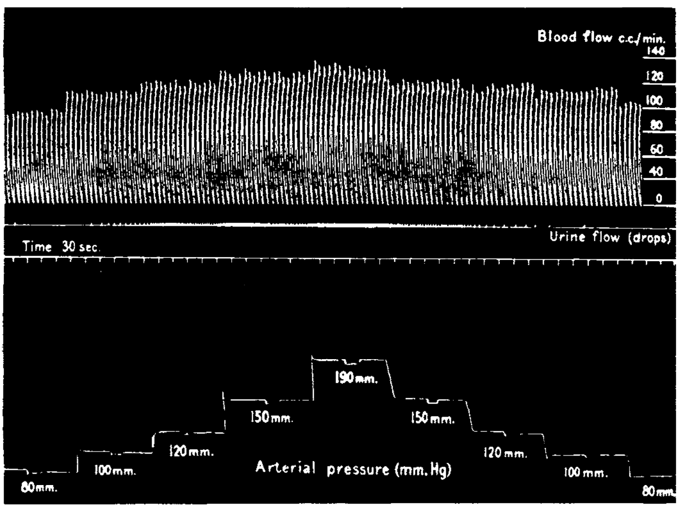


Fig. 1. Blood flow through kidney changes relatively little when perfusion pressure is varied between 80-200 mm Hg. (From Kramer and Winton, J. Physiol. 96:94, 1939.)

This phenomenon has since been studied by several groups of investigators in this country, in Belgium, in Germany and in England; it has been demonstrated in the kidneys of unanesthetized animals with both intact and denervated kidneys. It has been demonstrated in explanted kidneys, in the kidneys of anesthetized animals and in various perfused kidney preparations.

Closely associated with this regulation of blood flow is the regulation of GFR. One would expect, on the basis of current theories, that a rise in arterial pressure would produce a proportional increase in glomerular pressure and thus greatly increase the filtration rate.

In actual fact, however, a three-fold rise in arterial pressure—say from 70 to 210 mm Hg—usually results in less than a 50% increase in the filtration rate.

What are the mechanisms underlying this regulation of renal blood flow and GFR? Since the phenomenon occurs in isolated denervated kidneys, most workers have postulated that the smooth muscle of the renal arterial system automatically constricts when the intraluminal pressure is raised and automatically relaxes when the intraluminal pressure falls. In order to explain the regulation of GFR it is assumed that this intrinsic mechanism involves the pre-glomerular vessels.

This explanation is rendered unlikely, however, by the further observations of Winton that autoregulation is well maintained in kidneys which are cooled to 5°C or after chloral hydrate, in doses sufficient to paralyze smooth muscle, has been added to arterial blood. In the years 1936-39 I had the pleasure of working in Winton's laboratory and we frequently discussed these problems. But, we could not even postulate a rational mechanism to explain the fact.

It was not for another 15 years, in 1951, that a possible solution to these problems presented itself in the following way. I had gone to the Bowditch library one day to look up literature on the volume of blood contained in muscle capillaries. I came across a paper by Gibson, Aub, Fine, Seligman and a few other Boston notables who, in 1946, had attempted to measure separately the volume of red cells and of plasma in the minute vessels of various tissues. As we all know, the hematocrit ratio of blood within small vessels is somewhat less than that of blood in large vessels owing to the axial flow of the red cells. But the measurements made by Gibson et al. indicated that the kidney might be truly remarkable in this respect—according to their figures the hematocrit of intrarenal blood averages only 35% of that in blood entering or leaving the kidney. A discrepancy of this magnitude would hardly be accounted for in terms of axial flow, particularly in the kidney where the tortuosity of the peritubular capillary bed would not favor axial streaming. Yet, if the facts were correct - namely that the hematocrit of intrarenal blood is only one third that of arterial blood - then we are forced to the conclusion that red cells traverse the renal vascular bed at least three times as rapidly as the plasma.

Thus I was led to consider the possibility that blood entering the kidney is separated into two components—a cell-rish moiety which travels at high velocity through a short circulation and a slow plasma-rich fraction supplying the peritubular capillaries. At first thought this hypothesis seemed rather fanciful—but on further thought it grew more and more attractive because such a dual circulation would not only explain the low dynamic hematocrit of the kidney but it also offered a reasonable explanation for autoregulation of blood flow and for several other puzzling characteristics of the kidney as well. How could it explain autoregulation? You will recall that the viscous resistance to flow of blood in small tubes varies in a peculiar fashion with the corpuscular concentration.

In the range 0-40% cells there is no large change in viscosity. Above 50%, however, the viscous resistance to flow increases very

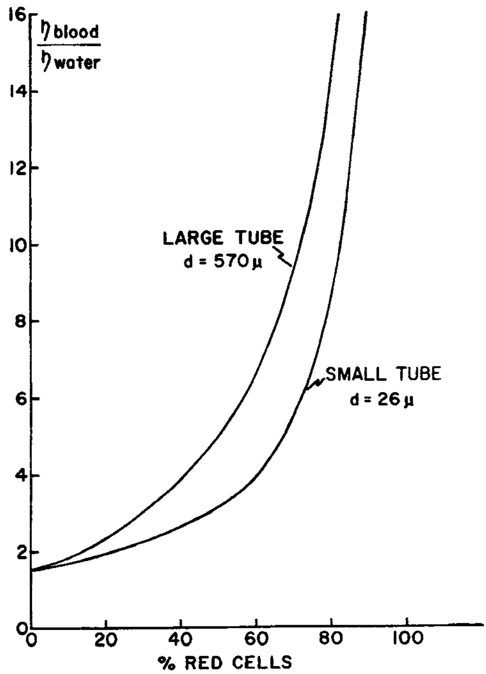


Fig. 2. Viscosity vs. hematocrit. (From data on dog blood by L. E. Bayliss, 1952.)

rapidly with cell concentration particularly in tubes of arteriolar dimensions. According to our hypothesis the total resistance to flow through the kidney is determined by two circulations in parallel. The resistance offered by the cell-rich circuit would be very sensitive to the efficiency of the cell separation mechanism - whereas the plasma-rich circuit would be relatively unaffected by the degree of cell-separation. It seemed reasonable to suppose that the energy for the separation process would come from the kinetic energy of the blood and would therefore be a function of the perfusion pressure. The higher the pressure, the more efficient the cell-separation process and therefore the greater would be the viscosity and resistance to flow in the cell-rich circuit.

It was not until 1953 that W. B. Kinter and I set out to test this preliminary theory in detail. In the interim, two more papers had come out indicating that the dynamic hematocrit of intrarenal blood is indeed lower than that of arterial blood. The score stood as shown in figure 3.

These data were all determined by using tagged albumin as a measure of the intravascular plasma volume and tagged red cells or hemoglobin as a measure of the intravascular red cell volume. If some of the tagged albumin leaked out into the renal interstitial fluid then this method would give an erroneously large plasma volume and an erroneously small intrarenal hematocrit value. In order to eliminate this

$$\frac{\text{Hematocrit of blood in kidney}}{\text{Hematocrit of venous blood}}$$

Species and No. of determinations	Method	Mean and variation	Reference
1) Dog (7)	Excise kidney after death. Drain large vessels. Analyze whole kidney for red cells (Fe^{59}) and albumin (I^{131} or T-1824)	0.35	Gibson et al. J. Clin. Invest. 25 848, (1946)
2) Dog (6)	Suddenly clamp renal pedicle. Analyze kidney for red cells (P^{32}) and for albumin (T-1824)	0.49 ± 0.1	Allen & Reeves Am. J. Physiol. 175 218, (1953)
3) Rat (14)	Suddenly tie renal artery and vein. Analyze kidney for Hb (acid hematin) and albumin (T-1824)	0.73 ± .13	Lewis et al. J. Lab. & Clin. Med. 39 704, (1952)

Fig. 3. Hematocrit of blood within the kidney.

possibility we devised a technique which would be unaffected by leakage of protein from the vascular system. A series of 20 cats was treated as follows: the corpuscular concentration in the blood of each cat was adjusted to some value between 5 and 80% red cells. This was accomplished by successive bleeding and transfusion of red cells or of plasma. The animals breathed oxygen so that they would tolerate low red cell concentrations. The renal pedicle was then tied suddenly and the kidney, with its contained blood, excised, homogenized and analyzed for hemoglobin. A sample of arterial blood was analyzed in the same way so that we could convert our hemoglobin values to red cell volume. The results are shown in figure 4 A.

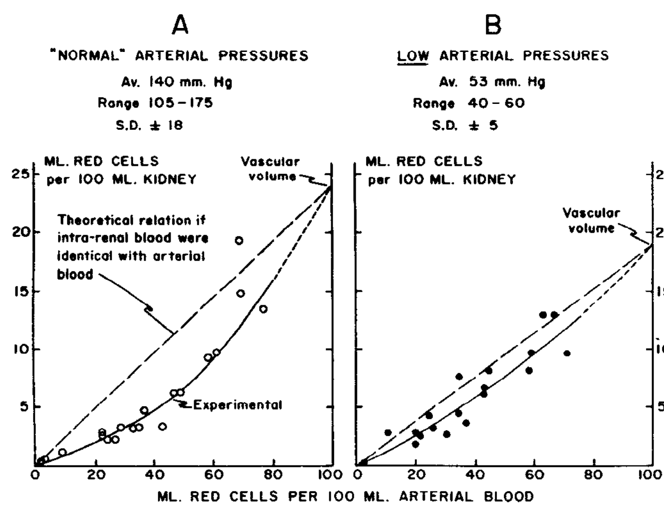


Fig. 4. Concentration of red blood corpuscles in cat kidneys.

It is obvious that there is something very peculiar about the renal circulation. In a glass tube or in other organs, such as the tongue which we used as a control, the hemoglobin content of the tissue increases in simple proportion to the concentration of cells in incoming blood. The kidney, however, departs greatly from this simple relationship. With 40% red cells in arterial blood, there are less than one half the expected volume of red cells in the kidney. If arterial blood contained 100% cells, then the kidney content of cells would be equal to the vascular volume of the kidney. The intrarenal vascular volume - obtained by extrapolation to 100% cells - is about 24% of the kidney volume at these normal blood pressures. Simultaneously we also measured the I-131 albumin space in each one of these kidneys. The results checked nicely with the extrapolation method... that is, the sum of each albumin space plus red cell volume averaged 24.8% of the kidney volume.

On the basis of these experiments we felt justified in concluding that the dynamic hematocrit of intrarenal blood really is very much lower than that of blood entering or leaving the kidney. All of these measurements were carried out at a fairly high blood pressure, averaging 140 mm Hg.

What about low pressures? If our theory were correct, the efficiency of separation of cells from plasma would be reduced at low pressures and under these circumstances the corpuscular concentration of intrarenal blood should approach that of arterial blood. Most cats have two kidneys - so that we took out one at high pressure and one at low pressure - the low pressure being obtained by an adjustable clamp on the aorta proximal to the kidneys. (See fig. 4.)

At low pressures the corpuscular content of the kidney increases almost in proportion to the red cell content of arterial blood. The vascular volume, obtained by extrapolation to 100% cells, was 19% of the kidney volume as compared to 24% at high pressure. Here again we have an independent check, because the weights of the kidneys taken at low pressure averaged exactly 5% less than those taken at high. We can summarize our results thus far in figure 5.

The effects of pressure on the distribution of red cells within the kidney are so great that there are actually more red cells in kidneys removed at low pressure than at high despite the decrease in vascular volume. Homogenates from low pressure kidneys are visibly redder than those from high pressure controls.

Most of the vascular volume within the kidney is contributed by the peritubular vessels in the renal cortex and this enabled us to apply a third method, applicable to the functioning kidney in vivo. We allowed donor cats to incorporate P-32 into the phospholipid of their red cells and of their plasma proteins. After suitable treatment of the cells and plasma from such a donor one can obtain either labelled cells or labelled protein for injection into other experimental animals. These animals were prepared as shown in figure 6.

The results of these experiments were clear, as shown in figure 7.

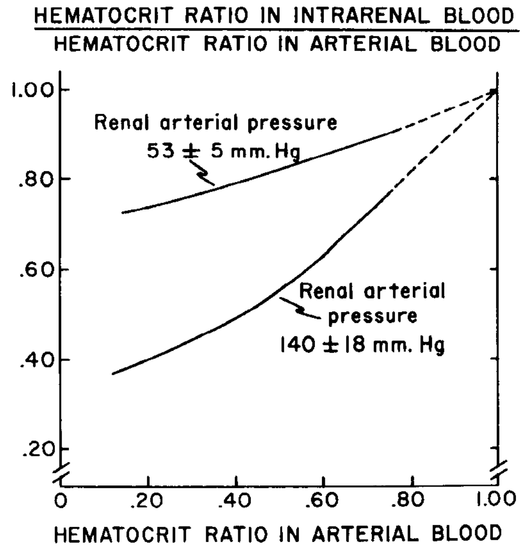


Fig. 5. Effect of arterial pressure on the dynamic hematocrit of the kidney.

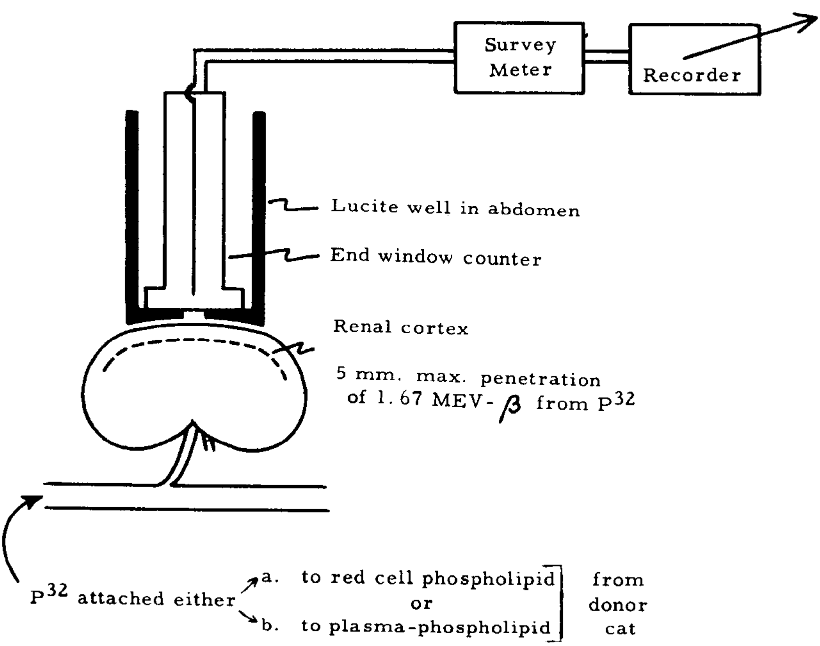


Fig. 6. Method of measurement of surface radiation.

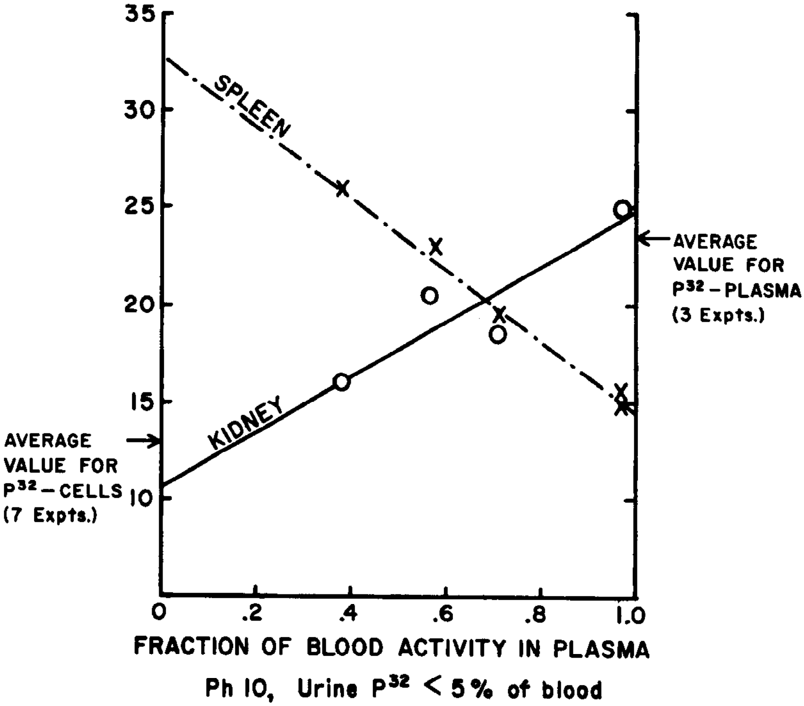


Fig. 7. Surface radiation--in % of that over equivalent area of arterial blood.

When P-32 was injected in the form of plasma protein there was twice as much radiation at the surface of the kidney than when the same amount of radioactivity was injected in the form of red cells. Once again we are led to the conclusion that the dynamic hematocrit of intrarenal blood is only about one half that of arterial blood. Here the spleen serves as an interesting control - where the red cell concentration is relatively greater than the plasma concentration and conditions are reversed.

I turn now to an entirely different approach to the problem. Our theory supposes that there are two circulations within the kidney—a long peritubular circulation containing mostly plasma and a short circulation traversed by a highly viscous mass of red cells. Suppose, now, we were to remove the red cells. In this case plasma would be free to traverse the short circulation, thus bypassing the tubules. Substances dissolved in plasma and normally removed into the urine by the tubules - substances such as PAH or Diodrast - should then appear in renal venous blood. To our great excitement and delight this proved to be the case.

Although the extraction ratios were decreased at low red cell concentrations, the clearances and tubular transfer rates of Diodrast and PAH were actually increased. In a separate series of experiments

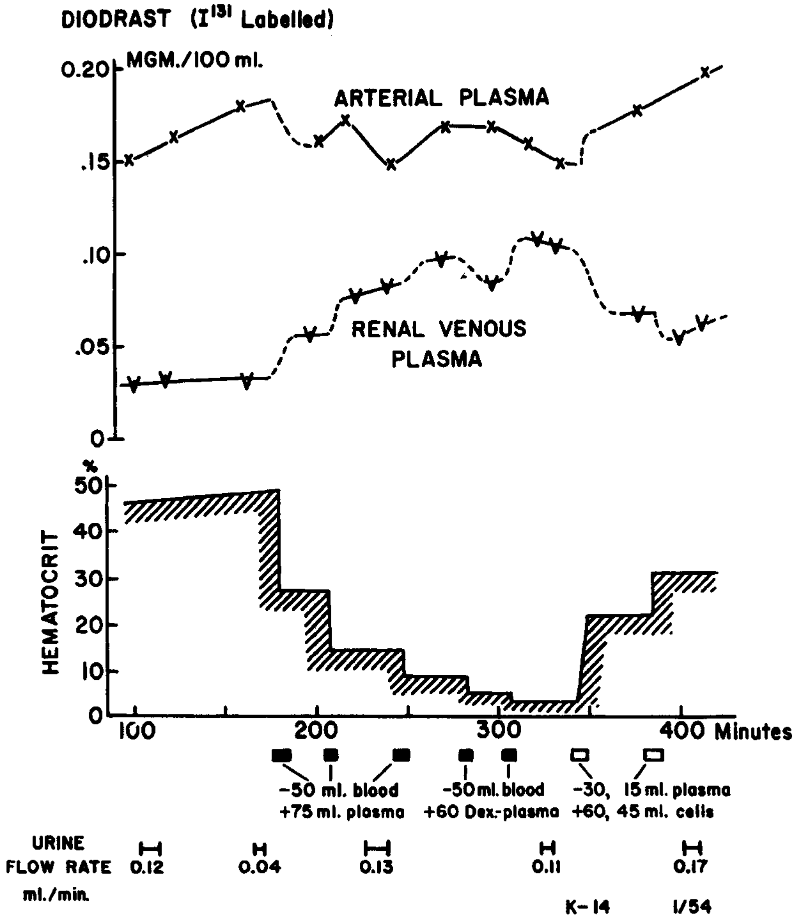


Fig. 8. Renal extraction of Diodrast (anesthetized cat breathing oxygen).

we showed that the transfer maxima of these substances were unaffected by variations in arterial red cell concentration.

These experiments fit in with the cell separation theory but they could not be explained by previous concepts. They cast a very different light on the significance of extraction ratios. On the basis of previous theories there was no clear explanation of why the extraction of PAH was only 90%. The discrepancy between 90% and 100% was generally assumed to result from uncleared plasma passing through fat and connective tissue in the kidney. However, 10% of the renal blood flow is about 40 ml/min/100 gm of kidney and it would be hard to believe that this large flow rate would supply the few grams of CT present in 100 gm of kidney. Moreover, in anesthetized animals the extraction ratio of these substances is generally closer to 75% rather than 90% and

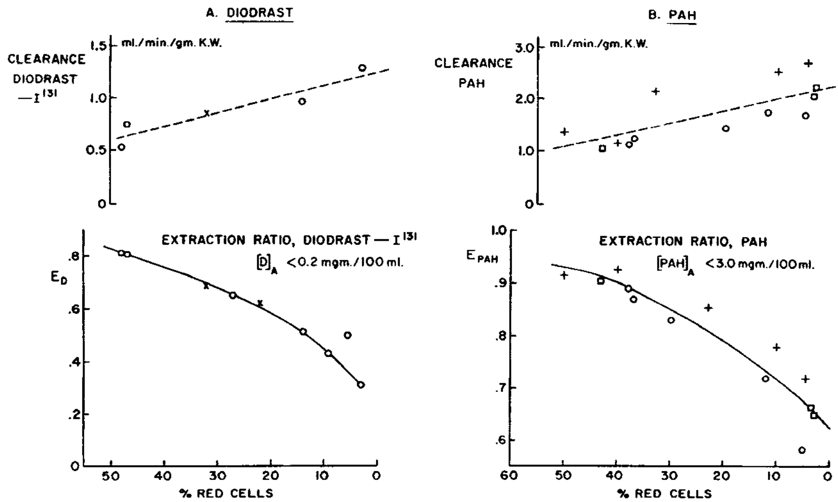


Fig. 9. Effect of red cells on renal clearances and extraction ratios of Diodrast and PAH (anesthetized cats breathing oxygen).

there was no rational explanation for this. According to our new theory, the relative concentration of PAH in renal venous plasma depends upon the amount of plasma accompanying the cell-rich moiety of blood in the short circulation — it is an indication of the efficiency of the cell-separation process.

The next step in our analysis was to determine if autoregulation of the renal circulation would disappear when red cells were removed and reappear when red cells were restored. This is a simple step in theory and a crucial one - but it is not so easy to tackle from an experimental point of view. When red cells are removed from an animal the blood pressure is likely to be low and some sort of mechanical perfusion system is required to vary the pressure over a wide range of values. And, we have yet to see a perfused kidney preparation which maintains normal function for periods long enough to complete all the clearance periods we should like to have for this problem. Nevertheless, working within this limitation, we found a striking difference between the pressure-flow characteristics of kidneys perfused with cell-free plasma or Dextran on the one hand and normal blood on the other.

In the absence of red cells the kidney behaves as do other organs, that is, the flow increases in proportion - or more than in proportion to the perfusion pressure. The resistance to flow decreases - rather than increases - with pressure.

Similarly, the regulation of glomerular filtration rate is dependent upon the presence of red cells - it disappears when cells are removed and reappears when cells are restored.

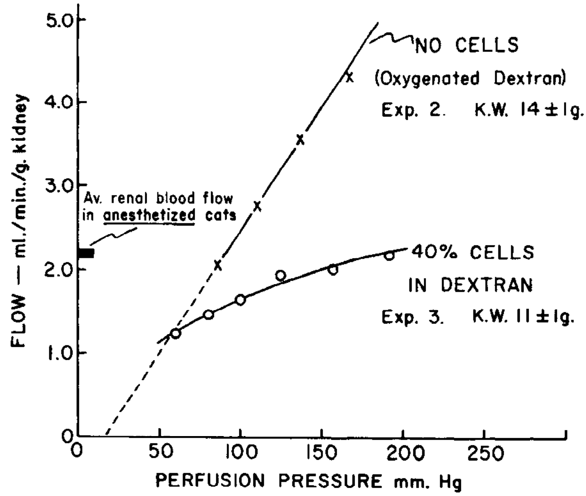


Fig. 10. Isolated perfused cat kidneys. (K-2,3; 10/53.)

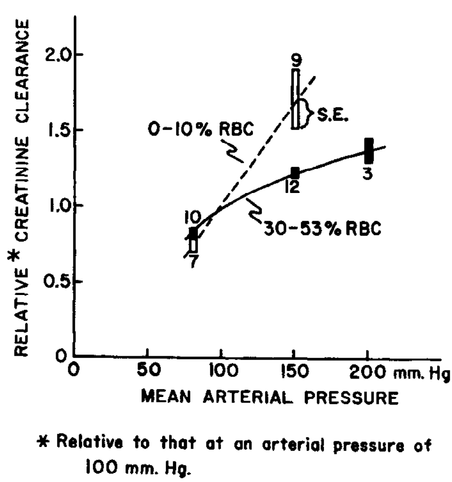


Fig. 11. Effect of arterial pressure on creatinine clearance at normal and low hematocrit (cat and dog kidneys).

Figure 11 is pooled data from many experiments using various types of operative procedures. In order to compare the different kidneys, one with another, the glomerular filtration rate at each pressure is expressed relative to that at 100 mm Hg arterial pressure. Clearly, the red cells play an important role in the regulation of glomerular filtration rate as well as blood flow.

Let us now try to be a little more specific about the cell-separation theory. Where in the kidney does separation occur and how does it operate to control filtration rate as well as blood flow?

Fig. 12. Latex cast.

Figure 12 shows a latex cast of a human renal arterial tree, one of More & Duff's injections. Note the long interlobular arteries with the afferent arterioles coming off at right angles to supply the glomeruli. The geometry could hardly be more favorable for plasma skimming. Blood enters the interlobular arteries at high pressure and velocity with the cells in the axis of the flow stream and the plasma in the peripheral layer adjacent to the right angle branches. We may suppose that the plasma layer is drained off by the first afferent arterioles, leaving an increasingly cell-rich component to continue to the terminal arterioles.

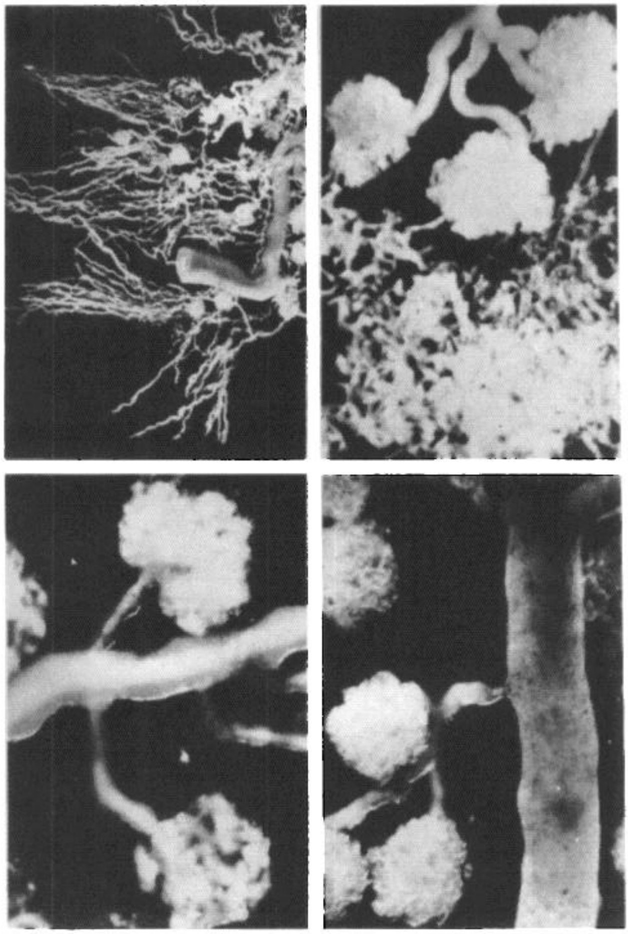


Fig. 13. High power--More & Duff, 60 micron interlobulars, 30 micron afferents.

Plasma skimming of the type I am suggesting can readily be demonstrated in model capillary T-tubes, as shown in figure 14.

One can make T-tubes of dimensions not greatly different from the interlobular and afferent arterioles. The one illustrated here has a central bore of effective diameter 91 microns and side branches of 46 microns, these values being obtained by calibration with water flow. At a juncture pressure of 130 mm Hg the axial flow of cells was easily visible under the microscope - - 47.5% cells came out the central channel and 39% from the longest side arm. One can readily imagine that with a series of such junctions corresponding to the renal arterial tree, a very considerable degree of separation could be achieved.

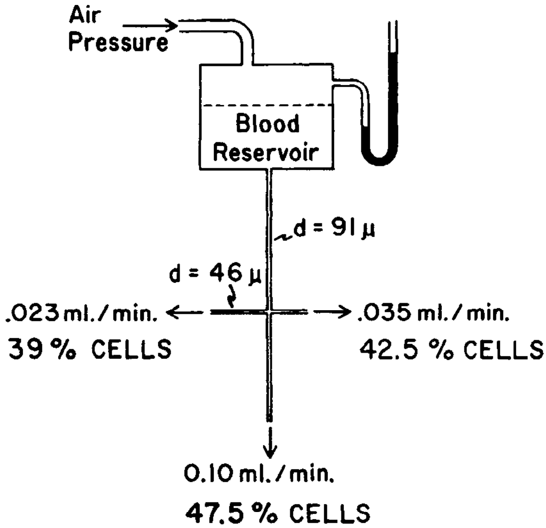


Fig. 14. Separation of cells from plasma in model branched network. Junction pressure (calculated) = 130 mm Hg. (J. N. and J. R. P., 4/26/56.)

Let us now complete our analysis of what may happen in the kidney.

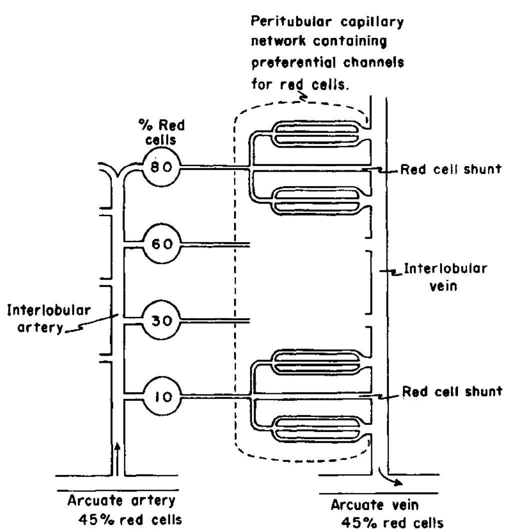


Fig. 15. Diagram illustrating cell-separation theory of renal hemodynamics.

Figure 15 is a diagram of the proposed distribution of cells and plasma within the kidney. In the arterial system there is a gradient of red cell concentration as we have described - owing to plasma skimming from the interlobular artery. Most of the resistance to blood flow comes from the terminal units, which have to carry the cell rich mixture. Now suppose we reduce the perfusion pressure; this will tend to reduce velocity and decrease plasma skimming. The distribution of cells will become more uniform, so that the outer units will contain say 60% red cells rather than 80% and the basal units perhaps 30% instead of 10%. Owing to the peculiar shape of the viscosity = red cell curve (fig. 2) this results in a great drop in resistance to flow through the outer units but little corresponding increase in resistance to flow through the basal units. The total resistance to flow therefore decreases greatly with pressure.

What about the regulation of GFR? The cell-separation theory suggests a drastic revision of our classical concepts. It has previously been assumed that the afferent arterioles normally offer 30-50% of the total resistance to flow through the renal vascular system. The glomerular pressure and hence filtration rate were supposed to be limited and controlled by the afferent relative to the efferent resistance. From an anatomical point of view this assumption would be hard to justify, although there were functional reasons for making the assumption. The majority of afferents are larger and shorter than the efferents and a simple calculation from Poiseuille's Law indicates that the pressure drop through them should not be more than 1 or 2 mm Hg. Indeed one may compute that the average diameter of the afferent arterioles would have to be less than 12 microns - scarcely more than the diameter of a capillary - in order to produce a pressure drop of 25 mm Hg. According to the new theory, however, the hydrostatic pressure in the glomeruli may be close to arterial pressure. Filtration rate is normally limited — not by hydrostatic pressure, but rather by the small volume of plasma reaching the more peripheral units. For example, for each ml of plasma-rich blood supplying a basal glomerulus, 0.3 ml of plasma ultrafiltrate can be made without undue concentration of the protein. But in the terminal unit there is only 0.2 ml plasma per ml blood to start with and only a tiny volume could be filtered off without undue concentration of the plasma protein.

When the arterial pressure is reduced the distribution of cells becomes more uniform. Filtration through the basal units is reduced by the lowered pressure, but in the outer glomeruli it is increased since the restriction imposed by the volume flow of plasma to these units is removed. This, we propose, is the mechanism underlying the constancy of filtration rate as a function of arterial pressure. Indeed, the entire literature on afferent and efferent arteriolar resistances - beginning with the classical work of A. N. Richards and O. H. Plant - can be reinterpreted in these terms.

Where do the red cells go after they leave the efferent arterioles? We have no anatomical answer to this question at the present time. The functional evidence suggests that there is a short circulation bypassing the renal tubules - and hence we have drawn in these preferential channels for red cells, communicating directly with the interlobular veins. Relatively little is known about the anatomy of the peritubular circulation as compared with the arterial circulation. The best we can do today is to predict, on the basis of our hematocrit data and our extraction ratio data, that channels subserving this function will be found.

There is another aspect of autoregulation which is also explicable in terms of the new theory but not by the old. If red cells were uniformly distributed within the kidney, we should expect the blood flow to vary inversely with the viscosity of the incoming blood. That is, there should be a marked decrease in flow at abnormally high red cell concentrations but relatively little change in flow in the range 0-30% red cells where the viscosity changes least. Precisely the opposite result is found experimentally.

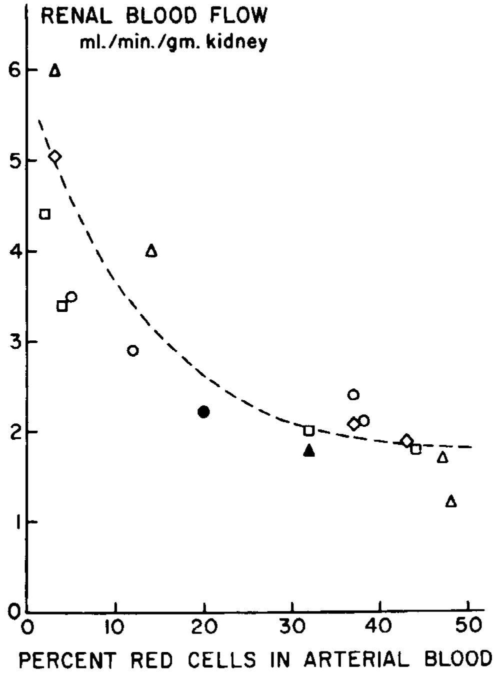


Fig. 16. Effect of arterial red cell concentration on renal blood flow at constant arterial pressure (anesthetized cats breathing oxygen).

The renal blood flow, measured at constant pressure, is relatively independent of cell concentration at high cell concentrations, but increases greatly when cells are removed in the range less than 20%. This anomalous behavior would be expected on the basis of cell-separation theory. Thus addition of red cells cannot further increase the already high concentration of cells in the peripheral units; instead it merely fills up the basal units and this does not greatly increase the resistance to flow since viscosity changes but little in the range 10-40% cells. On the other hand, when sufficient cells are removed from arterial blood so that their concentration in the normally cell-rich half starts decreasing, then this causes a large decrease in viscosity and increase in blood flow.

The cell separation theory has many other implications for renal physiology. It implies a distribution of filtration rates among the glomeruli - a distribution which changes with pressure and blood flow. And this in turn may affect the splay in renal titration curves, the reabsorption of electrolytes and the times of appearance in the urine of substances injected into the blood. It provides a new interpretation for the mode of action of pharmacological agents on the renal circulation. It raises some interesting and important questions about the oxygen supply to renal tubules and the redistribution of red cells during hypoxemia. Questions arise in connection with diseases of the kidney and with experimental hypertension. Some of these problems are already under investigation and I have no doubt that the theory as presented tonight will have to be modified as new facts come to light. In looking to the future of our theory I am reminded of a couplet - written by my sister when she was a little girl.

Oh!, Fancy's from defeat intact
But Fancy by itself cannot
Defeat the undefeatable Fact
So half and half's our lot.

CONFERENCE ON THE CHEMICAL ORGANIZATION OF CELLS: NORMAL AND ABNORMAL

Madison, Wisconsin: 21, 22, 23 August, 1958

The Subjects and Speakers will include the following:

"Nutrition and the Cell," G. O. Gey
"The Cell in Development," Paul A. Weiss
"Adaptive Enzymes," Van R. Potter
"Mechanisms of Hormone Action," C. C. Kochakian
"Organization of Electron Transport in Cells," David Green
"Organization in Cells of Different Kinds," A. J. Dalton
"Protein Synthesis in the Pituitary," C. H. Li
"Division of Labor in Cells," G. H. Bourne
"Virus and Cell," Frederik B. Bang
"Nucleoprotein," A. G. Marshak
"Pituitary Cell Reactions to Body States," S. C. Sommers
"Chromosomes, Nucleic Acid, and Information Theory," Henry Quastler

For further information and reservations write to Dr. Joseph J. Lalich, Professor of Pathology, 426 North Charter Street, Madison 6, Wisconsin.

XXI INTERNATIONAL CONGRESS OF PHYSIOLOGY

Buenos Aires, August 9-15, 1959

The members of the Society will be glad to know that plans for the XXI International Congress are progressing smoothly. The Congress is scheduled to meet in Buenos Aires, August 9-15, 1959, under the chairmanship of Professor B. A. Houssay. The Executive Committee of the International Union of Physiological Sciences held a meeting in New York in November for a discussion of the plans. The U. S. National Committee of the International Union (IUPS) has also discussed plans and appointed Dr. Carl F. Schmidt as its representative on an informal committee largely concerned with finances. Other members of the committee are Dr. C. Heymans of Belgium and Dr. Houssay. This committee held a meeting in December in New York. A considerable sum of money has already been collected, largely from the generous contributions of the pharmacéutical industries (see announcement in Science Vol. 126, pg. 460, 1957) and has been sent to the Local Committee in Buenos Aires to assist in the expenses of the Congress. Dr. Houssay writes that the organizing work is proceeding rapidly now that the summer vacation in Argentina is over.

Dr. Schmidt has reported that the following plans have been drawn up. Every morning between 9:30 and 11:00 a. m. there will be about twenty simultaneous sessions for the delivery of papers offered by members of the Congress. At 11:30 there will be a series of half-hour "conferences" or lectures by invited speakers. On each of five successive afternoons, three symposia have been arranged, with three speakers for each and a chairman. Invitations to these speakers and chairmen are now being issued.

The U. S. National Committee for IUPS is appointed by the National Academy of Sciences and includes three representatives nominated by the American Physiological Society, three nominated by the American Society for Pharmacology and Experimental Therapeutics, and two nominated by the Society of General Physiologists. In addition, there is one representative of the National Research Council. The committee is now operated under the sponsorship of the Division of Medical Sciences of the National Research Council, of which Dr. R. Keith Cannan is Chairman. Members of the Committee include Wallace O. Fenn, Chairman; Carl F. Schmidt, Vice-Chairman; K. K. Chen, Secretary; Maurice B. Visscher, Secretary-General of IUPS; R. W. Gerard, M. H. Seevers, C. Ladd Prosser, H. Burr Steinbach and J. A. Shannon.

The National Committee has been authorized by the Council of the National Academy to collect funds to cover travel for a limited number of persons who wish to attend the Congress. Conditions of these travel awards will be announced probably some time during the summer. The amounts awarded will probably not exceed $750 for each person. Because of the great distance, chartered boats are considered impractical and chartered planes have not proved successful in the past. Travellers will probably be expected therefore to make their own arrangements for the trip and there will be no official travel agent to take care of participants.

The Headquarters of the National Committee is at the National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D. C. Mrs. Phyllis A. Danielson is in charge of arrangements for the committee.

Wallace O. Fenn, Chairman, National Committee.

INTERNATIONAL MEETINGS–1958 AND 1959

1958

June 22-28 — Montreal, Canada
INTERNATIONAL CONGRESS OF OBSTETRICS AND GYNECOLOGY
Dr. R. Simard, 1414 Drummond St., Montreal.

June 25-July 1 — Stockholm, Sweden
CONGRESS OF INTERNATIONAL SOCIETY OF UROLOGY
D. G. Giertz, Karolinska Sjukhuset, Stockholm 60.

July 16-23 — London, England
INTERNATIONAL CONGRESS OF ZOOLOGY
% British Museum (Natural History), Cromwell Road, London, S.W. 7.

Aug. 4-7 — Stockholm, Sweden
INTERNATIONAL CONGRESS OF MICROBIOLOGY
Dr. C. G. Heden, Karlinska Institutet, Stockholm.

Aug. 10-16 — Burlington, Vermont
INTERNATIONAL CONGRESS OF RADIATION RESEARCH
Dr. J. S. Coleman, 2101 Constitution Ave., Washington 25, D. C.

Aug. 20-27 — Montreal, Canada
INTERNATIONAL CONGRESS OF GENETICS
Prof. J. W. Boyles, McGill Univ., Montreal.

Sept. 1-7 — Vienna, Austria
INTERNATIONAL UNION OF BIOCHEMISTRY
Prof. O. Hoffman-Ostenhof, Wahringerstrasse 42, Vienna IX.

Sept. 5-13 — Lisbon, Portugal
INTERNATIONAL CONGRESS OF TROPICAL MEDICINE AND MALARIA
Prof. M. R. Pinto, Instituto de Medecina Tropical, Lisbon.

Sept. 7-11	Tokyo, Japan INTERNATIONAL CONGRESS ON DISEASES OF THE CHEST M. Kornfeld, 112 Chestnut St., Chicago 11, Ill.
Sept. 7-12	Blaney Park, Michigan LAURENTIAN HORMONE CONFERENCE Dr. G. Pincus, 222 Maple Ave., Shrewsbury, Mass.
Sept. 8-13	Rome, Italy INTERNATIONAL CONGRESS OF HEMATOLOGY Dr. S. Haberman, 3600 Gaston Ave., Dallas, Texas.
Sept. 8-15	Brussels, Belgium INTERNATIONAL CONGRESS OF OPHTHALMOLOGY Prof. J. François, 15 Place de Smet-de-Naeyer, Ghent, Belgium.
Sept. 14-21	Brussels, Belgium WORLD CONGRESS OF CARDIOLOGY Dr. F. Van Dooren, 80 rue Mercelis, Brussels.
Sept. 25-28	Venice, Italy INTERNATIONAL CONGRESS OF ANGIOLOGY AND HISTOPATHOLOGY Dr. L. Gerson, 4 rue Pasquier, Paris, France.
Sept. 28-Oct. 2	Montpellier, France INTERNATIONAL CONGRESS OF HISTORY OF MEDICINE Dr. F. A. Sondervorst, 124 Avenue des Allies, Louvain, Belgium.
Sept. 28-Oct. 2	Rome, Italy INTERNATIONAL CONGRESS OF BLOOD TRANSFUSIONS Colonel Med. Julliard, 57 Boulevard d'Auteuil, Boulogne/Seine, France.
Nov. 2-7	Lima, Peru PAN AMERICAN CONGRESS OF RADIOLOGY Dr. V. Ubillus, 530 Avenue Saena Pena, Calloa, Peru.
Nov. 16-23	Washington, D. C. INTERNATIONAL CONFERENCE ON SCIENTIFIC INFORMATION Dr. B. Adkinson, 2101 Constitution Ave., Washington 25.
1959	
May 30-June 6	Milan, Italy INTERNATIONAL CONGRESS OF INFECTIOUS DISEASES Prof. F. Colonnello, c.di Porta Nueva 46, Milan.

July 19-25	Montreal, Canada INTERNATIONAL CONGRESS OF PEDIATRICS Dr. R. L. Denton, 2300 Tupper St., Montreal 25.
July 23-30	Munich, Germany INTERNATIONAL CONGRESS OF RADIOLOGY Prof. B. Rajewsky, 70 Forsthausstrasse, Frankfurt Am Main-Sud, Germany.
Aug. 9-15	Buenos Aires, Argentina INTERNATIONAL CONGRESS OF PHYSIOLOGICAL SCIENCES Prof. A. O. M. Stoppani, Facultad de Ciencias Medicas, Paraguay 2155, Buenos Aires.
Aug. 30-Sept. 4	Chicago, Illinois WORLD CONFERENCE ON MEDICAL EDUCATION World Medical Assoc., 10 Columbus Circle, New York 19, N. Y.
Sept. 3-5	Geneva, Switzerland (probable) INTERNATIONAL CONGRESS OF RENAL PHYSIOPATHOLOGY Dr. G. Richet, 149 rue de Sevres, Paris 7e, France.

FIFTY-YEAR MEMBERS

At the Business Meeting in Philadelphia the Society honored the following people who have been members of the Society for 50 years or more. The Society is proud to count among its members such distinguished scientists who have held membership in the Society and served the Society for so many years. The date of membership is given after each name. R refers to retired member.

Amberg, Samuel	- 1903 R	Loeb, Leo	- 1907 R
Brown, Edgar D.	- 1907 R	McGuigan, Hugh A.	- 1907 R
Dawson, Percy M.	- 1900 R	Meek, Walter J.	- 1908 R
Erlanger, Joseph	- 1901 R	Murlin, John R.	- 1906 R
Eyster, John A. E.	- 1906 R	Opie, Eugene L.	- 1906 R
Fischer, Martin H.	- 1901	Richards, Alfred N.	- 1900 R
Guthrie, Charles C.	- 1905 R	Snyder, Charles D.	- 1907 R
Hale, Worth	- 1908 R	Sollmann, Torald	- 1902 R
Harrison, Ross G.	- 1906 R	Voegtlin, Carl	- 1908 R
Hawk, Philip B.	- 1903	Watson, John B.	- 1907
Herrick, C. Judson	- 1907 R	Wiggers, Carl J.	- 1907 R

SOME OBSERVATIONS ON THE TEACHING OF PHYSIOLOGY IN STATE UNIVERSITIES

By E. F. Adolph

My "teaching tour" under the auspices of the APS Committee on Education was made in November and December 1957 and consisted of 2-day visits to three state universities. The present report summarizes certain observations and conclusions based upon it. A previous teaching tour by Dr. W. R. Amberson was reported in the APS Newsletter of Spring 1957, pp. 13-16.

The purpose of the tour was to find what factors influence the current attitudes in physiology teaching. State universities are the universities that are now explosively increasing in size. Fifty years ago less than 30% of students of higher education were in state-supported institutions. Today 50% are there. It has been estimated that 40 years hence at least 70% of students will be in tax-supported colleges and universities. This differentiation into state students and "small-college" students is one phase of the changes in education that are now occurring in the United States. I was particularly interested in finding out how mushrooming state universities differ internally from the older private universities in which most APS members grew up.

The tour is an indispensable part of the Committee's activities to see to what extent good teaching progresses along with good research. The tour did not aim to appraise the teaching of physiology as practiced. However, I found that local physiologists asked for my opinions on what they are doing, and appreciated whatever specific comments I could offer. Conversations with faculty members and administration members were said to assist both of them to reorient and to work together, especially when they gathered to discuss long-range notions. The tourist learns about some of the frustrations which exist and indicates what is being done about them elsewhere. He need not formulate conclusions, for the points that crop up in discussion leave their own impressions. Hosts indicated that the visits stimulated appreciable amounts of soul searching about the aims and emphases in teaching. They stated they were encouraged to find that the APS has a positive concern with teaching.

The three universities visited were in Michigan and Florida. In them student enrollments range from 7,500 to 19,000 students. Much of the picture observed was duplicated among them. Altogether I talked with 20 faculty members in physiology, with additional ones in general biology, and with several deans. In addition to individual and multilateral conversations, I participated in three staff meetings, one class seminar, and a Sigma Xi address.

I tried to find out (a) which undergraduates are studying physiology, (b) what research activities are going on, (c) how graduate students are situated and (d) what elementary instruction in biology is like.

Undergraduate Students

Physiology is taught to undergraduates in all three universities, one in a discrete department, one in an autonomous division of a biology department, one in unidentifiable portions of a sprawling biology department. In the latter institution it is also represented by a separate department of a medical faculty. In this particular medical physiology department no difficulties or frustrations toward good teaching and research have arisen. It has highly motivated faculty members, teaches medical students in small groups and encourages student projects. For these reasons nothing further will be reported about it. However, the prevalent separation between physiologists in medical faculties and biologists in arts-and-science faculties is amazing, and something that St. Peter may one day call upon the highly regarded professors in medical faculties to explain.

Undergraduates in these three universities do not often major in physiology, nor in biology. Most instruction in physiology is designed for undergraduates who aim toward physical education, nursing, medical technology, home economics. Most courses are service courses. In other words, physiology is universally regarded as a technical subject and not as a science comparable to other sciences in basic education. Wherever physiology is recognized as a separate science, it is so recognized by virtue of its usefulness to other programs.

The quality of instruction in physiology for undergraduates seems good. Classes are not too large. My main doubt is whether the material taught and the attitudes inculcated are what the instructors consider to represent the best that has been thought and done in physiology. Often they feel bound to please someone other than a physiologist.

Those who teach the service courses occupy strategic positions, for they represent physiology to college students and to faculty colleagues. They have daily opportunities to interest students in physiology or to kill those interests. They signify what physiology is before a large educated population. In spite of the devotion of these teachers, physiology is not known among students generally as a basic science.

Research

Research activities and research attitudes appear to be of variable importance to the faculty members in the physiology groups visited. All members have either the Ph.D. degree, or the D.V.M. degree (in a department where veterinary students are taught), however, which means they have experienced the arduous work of critical discovery and scientific proving. These attitudes do not develop spontaneously, and their soundness is under suspicion by those who have not cultivated them. Nearly all current research efforts are aided by grants and contracts. Financial support of research appears to be available to all those faculty members who want it and have time to use it. Most believe they could use more funds to increase the stipends and number of graduate students, and for equipment and especially for space. Space is said by most physiologists to be a limiting factor. Of course most research space is used only a small fraction of the time, an inefficiency inherent in nearly all research activities.

In justifying its work to the university administrators, and in its requests for university support, only one of the three physiology staffs visited relies upon its research activities. The other two regard research as something for which the university does not pay and does not budget, but tolerates. The same universities like to advertise the research activities in them. Certainly most research is done without its being recognized as part of a faculty member's university duties. Occasionally it is regarded as done in time stolen from teaching duties.

In one university nearly all research in physiology is done in time paid for by the state experiment station. This arrangement with the station is the only means enabling faculty members there to devote themselves to research, and those of its members not so supported do no research.

Library materials are a problem in all new institutions. Journal subscriptions have started only recently. For the most part foreign language journals are little used and subscriptions to them are not favored where as always funds are limited.

The thought was expressed that the huge potential for physiological research that resides in the newly developed state universities has not been capitalized by the agencies responsible for supporting research in this country. Members of APS who belong to panels and study sections are in a position to ascertain whether this view has merit.

The state universities and their faculties are uncertain which way to lean in the great dichotomy now developing among institutions of higher learning. The larger universities and colleges receive research support and graduate students because they are already organized for research, and as a result they become greater. The smaller are starved because creative research is outside their post-war activities. So great is the pressure to increase student enrollments and to put all faculty efforts into undergraduate courses that these latter universities and colleges have usually not established the freedom, time and space that will give confidence to the granting agencies that can aid them.

Staff Members

Staff members in these universities feel isolated. They view on the one hand the well-situated physiologists who do research in the few established research centers, especially those in medical schools; and on the other hand the still more isolated physiologists who teach the subject as members of biology departments in small colleges. They state that the APS seems tailored to the needs of medical school physiologists. They feel they are forgotten men, partially ignored at national meetings (because they have not arrived research-wise), misunderstood by their own faculty colleagues (because they have no academic tradition), patronized only by students (most of whom want to become medical students or nurses). All staff members regularly attend meetings of professional societies and nearly all are members of at least one professional research society. Our Society could profitably make a penetrating study of how it can move to be of more use to non-medical physiologists.

Some university administrators believe research is a necessary adjunct to good teaching and to holding a brilliant faculty. Others still think research is an enemy of good teaching. Some would segregate research into a single university in each state. Though certain state universities implement research, most do not, thinking they can hold a satisfactory faculty without research recognition, and saying they lose only a few malcontents to more progressive institutions.

Staff members are devoted to their work. They seemed to be deeply interested in discussing their own attitudes toward students. Was their job that of taskmaster or of leader? That of information purveyor or of explorer? Did the student suffer when the expected topics of study were not all "covered"? Which was their highest contribution to the educational process?

Graduate Students

Altogether there are 33 graduate students majoring in physiology in the three universities visited. Graduate students are regarded as necessary to the conduct of undergraduate physiology courses. Since service courses form the backbone of the teaching program, expensive instructors would have to be obtained if graduate students did not work for subsistence. Other graduate student positions arise from the need for research assistants in sponsored research. One consequence of these two schemes is that the quota of student assistants is kept filled even when candidates are unsuitable. Disappointed premedical students and other unmotivated persons fill the gaps left by the lack of those who seek a career in the science of physiology. Nevertheless, I met some highly motivated graduate students, including some from other countries, who were preparing for academic careers.

Selection of graduate students is also not wide in area. Most are from the state, and are here because colleges of the state look to the nearest state university as the big institution. Most graduate students did not apply elsewhere than nearby—in other words, had no basis for preferring one graduate school over another.

Graduate students from other departments are offered course work in physiology, and in one university are offered research experience as well.

I gather the impression that many of the graduate students have excellent potentialities, only part of which are being realized. The students are confused by the talk of scholarship in a department where the faculty members are technical experts. They spend most of their time fulfilling some daily obligation instead of building for an unlimited future.

Elementary Biology

As one of the biological sciences, physiology will always be concerned with the pathway by which college students are introduced to the study of living things.

In each of the three universities I visited, a biology course is provided for 1000 to 2000 beginners each year. In two of the three, the course is partially divorced from the biology faculty, being managed by a "basic college" faculty. The degree of separation of faculties did not seem to make any difference in the method of instruction. In each university a set curriculum had been devised for the elementary course. One of the three courses did not include laboratory work but offered an elective in it as a separate parallel course. In all three the elementary course itself was required of nearly all college students.

The set curriculum gives instructors little chance to vary the routine or to inject their own strengths and enthusiasms. A basic assumption appears to be that what is desirable subject matter for one student should be uniform for all. Examinations determine the scope of the course, and grades derived from them are considered the criterion of successful accomplishment. Nearly all examinations are by machine, and the students cultivate the kinds of ingenuity needed to outguess the machine, chiefly by memorization of terms and set answers.

The painstaking observation and thought necessary in order to arrive at scientific principles are apparently neglected in these courses. The principles exist as statements to be memorized. Either the pains of self-questioning are necessary, or else some other criterion of what an elementary course can do for a non-scientific student needs to be developed. Biologists of today lack a way of determining whether any device successfully gives a basic understanding of biology as a science other than through the personal influence of a skilled teacher. Such influence is well recognized to become diluted with the number of students.

There are those who consider mass-education methods satisfactory in biological instruction; their belief needs some validation by methods other than those now used. Occasional teachers have successfully inspired their students in spite of large numbers.

There are those who think it appropriate to require a course in biology of all college students. This entails the assumption that 1000 students taught in what seems to me to be a treadmill will benefit humanity more than 100 taught in a course allowing initiative and individuality. This assumption determines the fate of biological science in the next generation. For, if it yields an unreal understanding of what scientific attitudes are, or if it discourages apt students from seeking careers in biology, no amount of advanced education can compensate for it.

Comments

Observations in three universities might be thought to be too few for the drawing of conclusions. But the observer draws also on additional random observations in other universities for comparisons. Further, he has the reports of other visitors to diverse institutions on which to rely.

There would be little point in reviewing the working conditions among academic physiologists if each represented only an isolated instance. Actually, however, the same academic difficulties are found in many situations. Some may be inherent in educational institutions, or in institutions of all kinds. Gone are the days when a state university was a collection of resident scholars. It is more of a behemoth machine, and everyone who has taken a hand in organizing and operating it is now afraid of his handiwork, and prone to blame those in other administrative echelons for its present state.

A possible generalization is that every person in an academic institution, just as in every other institution, subconsciously seeks the maximal security, first for himself and then for those for whom he feels personal responsibility. For the teacher, security is partly found in a large student enrollment; for the department chairman, in a large space and payroll; for the graduate student, in a sure-fire research project; and so on. All have "chosen" to live with a particular combination of relative securities and other satisfactions and dissatisfactions. Every professor leads a double life, trying to fulfill his daily obligations to institution and students, while reserving some time for his own intellectual advancement.

A professional society such as the APS fulfills an important function in strengthening the feeling of security among the members of the profession. When they are uncertain, they try to find what is done by colleagues elsewhere. When pressed upon by an administrator they guide their recommendations by the usages of other universities. Physiology extends itself in the curriculum of a given university partly because it is esteemed elsewhere. Research is believed to strengthen the teaching of physiology because leaders among physiologists are known by their researches. For these reasons a professional society serves its members when it expresses an active interest in all phases of their work, including teaching. In my experience, visits among colleagues add to the morale of all concerned.

A physiologist, like other scientists, is usually highly dependent on the physical environment in which he lives. His morale goes up with his space and his equipment, whether he could "get along" without it or not. The old practice, according to which research was done by use of class equipment on non-class days and of the animals left over from class, is no longer satisfying to anyone.

During the tour I noticed that distinctions between pure science and applied science are not important in the thinking of most physiologists. A phenomenon that one person would consider applied, was in the mind of another a special instance of a general principle. All physiology was considered by some to be applied because it had practical corollaries. A more emphatic distinction was between "ivory-tower" physiology which made few references to man or cow, and "realistic" physiology which used the man at altitude and calf at fattening as the basis of instruction and research. The General Physiology of the prewar generation was considered too abstract by some instructors. In their view, physiology need not appear in a university curriculum as a theoretical science, since it might receive readier justification as a practical one. The above various bases of justification are now determining the place of physiology in universities.

Any new institution, or one in the throes of present expansion, is almost bound to be a state college or university. Such an institution has unsettled characteristics. It has large numbers of students. It also has future prospects, since it is in process of change and enlargement, and hence allows certain types of individual effort to influence its course. It may attract faculty members who like to innovate and take chances. It contrasts strongly with the long-established university where the competition for "permanent" appointments in the faculty is exceedingly severe, and based largely on some visible form of "research" accomplishment. It also contrasts strongly with the privately supported college where most faculty members not only have full-time loads of teaching and advising, but also feel isolated from those interested in the same field of learning.

It is no wonder that each of these three types of institutions of higher learning has a different set of problems. My particular tour studied the state university in growing pains. Dr. Amberson and Dr. Martin studied the "small college." The large private university is familiar to most APS members because most came from there, and its situations have not greatly changed since then. When anyone transfers from one type of institution to another, he is not shedding all difficulties, but is mainly substituting one set for another. However, difficulties are also challenges, and institutional problems are being successfully solved by many hard-working physiologists.

AAAS FELLOWS

Members of the American Physiological Society who are also members of the American Association for the Advancement of Science are qualified for automatic fellowship in the AAAS. The AAAS would appreciate it if those who are currently AAAS members and do not have a AAAS fellowship certificate would advise the AAAS, 1515 Massachusetts Ave., N.W., Washington 5, D. C. - Raymond L. Taylor.

ESTABLISHMENT OF THE RETIRED PROFESSORS REGISTRY

A Joint Project of the Association of American Colleges and The American Association of University Professors

The Registry is financed by a substantial grant from the Ford Foundation. The work of the Registry involves the establishment and the administration of a national register of retired college and university faculty members who desire to be considered for academic appointments in institutions other than those from which they have retired. This project is an effort to meet part of the need for academic personnel during the shortage of qualified people created by mounting student enrollments. Since retired faculty members constitute a significant manpower resource, the Registry will endeavor to establish contact between retired professors who wish to continue teaching and institutions interested in obtaining their services. The sponsoring Associations believe that the Registry can make a substantial contribution toward meeting the critical staffing problems of higher education.

As the health of individuals improves and their life-span increases, there is a possibility of prolonging employment beyond the present conventional ages of retirement. There is ample evidence that a substantial portion of the college and university faculty members who retire each year desire to continue in salaried teaching or research on either a full-time or a part-time basis. The rigidity of retirement systems keeps many faculty members from remaining in their present positions. The Registry will attempt to facilitate the employment elsewhere of those able to continue.

Retired professors will be asked to furnish information concerning their careers to the Registry. Their special abilities will then be matched with the requirements specified by institutions where academic positions are unfilled. The registrants will furnish references which will be checked by the officials of interested institutions, and the Registry will not attempt to make judgements concerning the competency of the retired professors. After the establishment of initial contacts, including the transmission of basic factual information about individuals to prospective employing institutions, the negotiation of employment arrangements will be left to the persons concerned.

The Retired Professors Registry is located at 1785 Massachusetts Avenue, N. W., Washington 6, D. C. Information and forms may be obtained by contacting the Registry.

Responsibility for general supervision of The Retired Professors Registry rests in a joint committee. The membership of the Committee includes: (for the Association of American Colleges) Dean Mark H. Ingraham of the University of Wisconsin; Dr. Thomas E. Jones, President of Earlham College; Dr. Goodrich C. White, Chancellor of Emory University; and (for the American Association of University Professors) Professor S. L. Pressey of The Ohio State University; Professor Louise E. Rorabacher of Purdue University; and Professor Homer C.

Bishop of Washington University in St. Louis. William C. Greenough will represent the Teachers Insurance and Annuity Association, and Dr. T. A. Distler and Dr. R. K. Carr will serve as ex officio members.

Dr. Louis D. Corson has been appointed Director of The Retired Professors Registry by the Joint Committee. Dr. Corson is now Dean of Men at the University of Alabama. He served as Dean of Men at Florida State University from 1953 to 1955 and was formerly a member of the Department of History at West Virginia University.

STATUS OF PHYSIOLOGISTS

The material for this report was prepared by Mrs. Ruth Habel of the Federation of American Societies for Experimental Biology Division of the National Roster of Scientific and Technical Personnel. The total Register is supported and maintained by the National Science Foundation. A detailed article on all disciplines represented in the Federation will appear in the July issue of Federation Proceedings.

This report is based on complete information received in 1956-57 from 9237 scientists of doctoral level working in the field of experimental biology. Of this number, 2675 (21%) listed physiology as their current major activity. Forty-three percent or 1147 of this group are active members of the American Physiological Society, thus 74% of the membership is included.

Table 1 gives a comparison of the functions of physiologists with those of certain other biologists. It will be noted that a relatively high percent indicated teaching of physiology as their primary function. The degrees of the total membership are inserted for comparative purposes.

Table 2 shows the distribution of physiologists according to type of employment. It will be seen that the majority are located in universities.

Table 3 indicates the spread of income levels of physiologists at the doctoral level. The income level in relation to activity and years of experience will be published in a later issue of THE PHYSIOLOGIST.

TABLE 1. DISTRIBUTION OF CERTAIN BIOLOGISTS BY DEGREE AND PRIMARY FUNCTION

FIELD	DEGREES						FUNCTION										
	M.D.		Ph.D.		Multiple Degrees		Teaching		Research		Adminis-tration		Clinical Investi-gation		Other		Total No.
	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	
Physiology	42	1129	46	1236	12	310	30	794	48	1278	8	215	12	325	2	63	2675
APS members *	35	584	45	741	18	290											
Biochemistry	10	174	84	1454	6	99	14	247	71	1224	10	166	2	39	3	51	1727 **
Pharmacology	29	204	56	386	15	107	23	158	54	377	14	95	5	38	4	29	697 **
Pathology	81	718	8	67	11	97	21	188	39	340	11	97	24	215	5	42	882
Nutrition	15	71	81	380	4	16	18	84	58	269	16	78	3	13	5	23	467
Microbiology	22	509	71	1628	7	172	24	559	50	1148	16	369	4	106	6	127	2309
Totals							23	2030	53	4636	12	1020	8	736	4	335	8757

*Two percent of membership have single degrees other than M.D. or Ph.D.

**The limitations on the completeness of the survey (questionnaires returned to the Federation) are most prominent in the case of biochemists and to a less extent for pharmacologists.

TABLE 2. DISTRIBUTION OF PHYSIOLOGISTS BY TYPE OF EMPLOYER AND PRIMARY FUNCTION

EMPLOYER	FUNCTION										
	Teaching		Research		Adminis-tration		Clinical Investi-gation		Other		Total No.
	%	#	%	#	%	#	%	#	%	#	
University	46	757	43	714	4	71	6	95	1	11	1648
Federal government	2	10	62	290	17	78	15	71	4	17	466
Private industry	0	0	53	63	23	28	11	13	13	16	120
Non-profit	3	9	69	163	11	24	14	32	3	9	237
Other	9	18	24	48	6	14	56	114	5	10	204
Totals	30	794	48	1278	8	215	12	325	2	63	2675

TABLE 3. INCOME LEVELS OF PHYSIOLOGISTS

INCOME	%	NUMBER
$ Below 2,000	1.8	50
2,000 - 3,999	3.6	97
4,000 - 5,999	14.6	391
6,000 - 6,999	13.5	362
7,000 - 7,999	14.0	337
8,000 - 8,999	10.0	276
9,000 - 9,999	7.0	200
10,000 - 11,999	12.8	344
12,000 - 15,999	13.7	370
16,000 - 19,999	4.0	112
20,000 - and over	5.0	136
Total	100	2675

SOME OBSTACLES TO THE ENCOURAGEMENT OF RESEARCH IN OUR COLLEGES

By Arthur W. Martin

One of the programs of the Committee on Education of the American Physiological Society, supported by the National Science Foundation, the National Institutes of Health and the Society itself, is aimed at restoring to productive research properly trained individuals among college teachers who have lost contact with research activities for one reason or another. Members of the Society have opened their laboratories during the summer to one or more teachers, and have continued their interest in the visitors when the summer's work was done. A proper concern of the Society is the environment to which these individual teachers return and this report deals with one small aspect of the matter.

At the Eugene, Oregon, workshop for college teachers of physiology, where about 40 colleges and universities were represented, a discussion group exploring problems of teaching quickly gathered some comparative data about teaching loads. At 9 colleges and universities with a teaching and research tradition, ranging in size from Reed College (enrollment 700), to University of California at Berkeley (enrollment 16,000), teaching loads varied from indeterminate, e.g. no prescribed minimum, up to a maximum of 16 contact hours a week.

A mean was estimated at between 10 and 12 contact hours a week. It is hard to be sure just what 12 contact hours a week means in every instance; but a common complaint of university professors is that teaching loads are too high, especially when coupled with demands for research, graduate student guidance, student advising, committee work, community service, editorial and abstracting duties, etc. But at these nine schools it is presumed that faculty members choose their activities and research can be pursued.

If we turn next to the other colleges where full-time teaching is the tradition we find an entirely different situation. In a sample of 17 schools teaching loads varied from 16 to 30 contact hours a week, with a mean higher than 20. Depending upon the credit values of the various courses this represents a load of 2, 3 or 4 courses taught simultaneously, for which much preparation must be made outside of class hours. But teaching loads alone do not tell the whole story. Much less was provided to the faculties in these schools in secretarial, stockroom and laboratory help than to faculty members in the larger institutions. During each school year, therefore, an individual working at such an institution has little opportunity for pursuing an active research program.

My point is that there are valid reasons why research activities in these very schools may be of unusual advantage to the welfare of science and learning. The teachers generally deal with smaller classes than those handled in large universities and their contact with an individual student covers a longer period of time because each instructor teaches more courses and may have a biology major student in from 3 to 6 separate classes over a 4-year period. In this way they become well acquainted with the students and can exert a great influence upon the choice of a career. On the whole, too, the students at the smaller college tend to be less committed to a distinct profession than are university students. Our experience at a large university has been that many premedical and predental students select the university simply because of its professional schools and remain in the preprofessional curriculum as long as possible, choosing a major only with reluctance. The small schools also offer preprofessional curricula but in the writer's experience enjoy a proportionately larger number of biology majors. Under these circumstances a greater exposure to instructors carrying on research can play a decisive part in determining the choice of a career by more of the students at these colleges.

If we agree that research activity in the smaller colleges and schools may be desirable, what can be done to promote it?

First, we should call attention to the situation at the state level. Instructors at small colleges would welcome a statement of both current and desirable practices against which each college might measure its performance. Administrative officers may not even have recognized that a problem exists in some colleges. In others the problem is recognized but ammunition is lacking with which to seek increases in college support from the state legislature or private donors.

Second, we should call attention to this situation at the national level in this period of intensive discussion of federal support of education, with its reexamination of our national goals.

Third, we should seek more detailed information about teaching practices through agencies more widely representative of biology than the American Physiological Society.

Fourth, we should promote discussion of means of supporting such research. An inferior grade of research, supported independently of the main line of research support, should not be our goal. But an increased small grants program would allow selection; and competition in the normal channels might properly follow. In this case it is obvious that there will have to be increased funds at the disposal of these granting agencies.

REPORT OF THE PRESIDENT-ELECT'S TOUR

Topic: Practical Problems of Scientific Communication

By Hallowell Davis

Between October 23 and December 2, 1957 your President-Elect visited thirteen medical schools and the Mayo Clinic in the near northwest section of the country. The medical schools were those of the state universities of Michigan, Iowa, Wisconsin, Minnesota, South Dakota, Nebraska, Colorado, Kansas and Missouri and also of Marquette, Creighton, St. Louis and Washington Universities. The tour was strenuous, but it was rewarding to the treasury of the Society, thanks to the generous honoraria for lectures, and truly inspiring to the President-Elect. By the discussions of Society affairs, by the warm personal contacts, by broadening of his information and point of view, and by the fortification of his confidence in our Society and in the members that compose it, he is convinced more than ever that the tour is one of our very valuable institutions. It should certainly be continued as long as Presidents-Elect can be found year after year who are temporarily separable from their home duties, who will travel by any form of transportation, including horseback if necessary, who have good digestions, rugged vocal cords and strong right hands that can be shaken and elbows that can flex when necessary.

The topic selected this year for group discussions was "Certain Problems of Scientific Communication." Such communication, partly through our meetings and partly through our publications, is a major, if not <u>the</u> major function of our Society. And, although most members may now be fairly well satisfied with the status quo, the Society is faced with the problem of continued growth. Our membership of about 1600 is increasing by about 125 members per year; and few cities can properly accommodate the Federation meetings today. Dr. Lee has reported repeatedly to you about the growth in pages per year and words per page published in our journals, and has also told you of the actual decrease in subscription cost per million words: but costs per page must inevitably soon rise again, and the output of physiological manuscripts is increasing at an exponential rate.

The opinions of each local group were strikingly similar on most of the many problems and their possible solutions that were discussed. This must have been due in part to the common bias introduced by the President-Elect, who is not a professional poll-taker and who participated freely in the discussions. He reports his impressions to you, however, as his best appraisal of the sentiment of a fairly large sample of the Society membership and some members of other Federation societies.

Meetings

Our present policies and procedures in regard to meetings, both Federation meetings and Fall meetings, received a clear vote of confidence.

The Federation meeting is valued in spite of the growing congestion and confusion. A major reason is the opportunity to meet and to hear papers by members with similar interests, and also "the leaders of our own Society and of other societies." A second major reason is the opportunity to give a ten-minute paper. Even though it is not exercised every year the right to give a paper is very highly prized by our members. The restriction of the right of presentation to a single paper at the Spring meeting seems to have enhanced the prestige of the papers that are given, both for the listeners and for the speakers. When at last the pressure on time and available meeting rooms shall become intolerable the membership interviewed would almost unanimously prefer still further rationing of the right to speak, even to a paper every other year, rather than to invoke selection of papers by any mechanism that was proposed. "Selection" was immediately equated with "censorship." In much the same spirit the membership clearly favored retention of the right to sponsor a colleague on the spring program in case a member does not personally use his right to the ten minutes' time.

Other valued features of the Federation meeting, approximately in order of apparent importance, are the program abstracts, the commercial exhibits, the symposia, the opportunities for group dinners and discussion groups, and the opportunity for interviews relative to hiring or being hired for new jobs.

The Fall meetings of the Society as now organized and conducted are especially approved. They are regarded as important opportunities for the younger men to present papers, and the extension of this privilege to associate members meets with general favor. The teaching sessions are considered useful.

Two proposals for improvement of meetings were hailed with enthusiasm. One is the deliberate strengthening of the function of chairman at the sessions to make him a responsible leader of discussion and, if necessary, criticism, instead of being merely a half-hearted time-keeper. Good, lively, frank, open discussion should be possible if competent chairmen are selected carefully and are given explicit instructions, and if they are then provided with abstracts in advance. The second proposal is to introduce certain selected programs by thirty-minute invited papers, usually by the chairman. Such an invited paper would be a tutorial survey that would review the state of the field at the moment, and explain ideas, issues and problems, so that those who are not themselves experts can appreciate the significance of the subsequent papers. Such surveys should be of real value and interest to those who must teach subjects on which they are not first-hand experts.

Both the strong chairmanship and the invited papers were tried at the Philadelphia meeting.

Your President-Elect believes further, and a majority apparently agree with him, that the right to present a paper implies an obligation to give that paper as well as possible. The best formula for effective presentation is actual rehearsal in advance, with criticism and coaching by colleagues. Insistence on good technique of presentation should be a particular concern of the heads of departments and of all members who exercise their right of sponsorship. A good set of elementary recommendations have been evolved for an effective ten-minute presentation, for drawing effective slides, and for the use of one's voice to the best advantage, with or without a public address system. High standards can be enforced by social pressure and by the force of tradition and of example as well as by direct criticism and coaching. If we fall short or grow careless our best friends ought to tell us.

Publications

The present editorial policies and procedures likewise received a clear vote of confidence. Criticism was about equally divided between "too severe" and "too lax." It was definite but not too harsh on the side of "too slow"; but a six-month publication lag from date of mailing the manuscript was usually considered "tolerable although undesirable." The general sentiment was that pressure for priority and the importance of rapid dissemination of information to other laboratories is less in physiology at the present time than it is in biochemistry and pharmacology.

Various ways in which to reduce the publication lag, particularly for sound, well-written papers, were discussed, and soon each group agreed that the real problem was to submit in the first place papers that are sound, substantial and well written so that they do not need elaborate repeated editorial criticism and subsequent rewriting. Here, as with oral presentation, good technique begins at home. The head of a department carries a definite responsibility for literary quality, and a man's best critic is an interested colleague in his own or in another institution.

The membership of the Society clearly suffers from the misconception that brevity of presentation, a small number of pages, and conformity to an established pattern of reporting new data are all necessary conditions for acceptance of papers by the American Journal of Physiology and the Journal of Applied Physiology. The President-Elect explained that this is definitely not the present intent of the Board of Publication Trustees and that a) "methods" papers can be accepted for these journals, that b) length is no bar provided the density of data or ideas per page is high enough, and that c) an acceptable novel synthesis, such as may be expressed by new calculations or new conclusions drawn from old data, does not require the addition of new data to be acceptable. On the other hand, discussion does not necessarily need to be wordy, and it is the unnecessary words, which are expensive to print, and not the ideas that the editors try to eliminate. The editor is caught between his duty to allow the free expression of new ideas which may be unorthodox and his duty to give the subscribers their money's worth by rejecting "trash."

The membership agreed enthusiastically that, in addition to our usual four- to six-page papers, there is need for physiological papers that are both critical and synthetic. Such papers will usually be somewhat longer. They may or may not add new data but they should emphasize the emerging general principles. There should be a place in our journals for such papers. We may expect and hope that such "idea papers" will be generated in the form of the "invited papers" that will introduce some of our sessions at the spring and fall meetings.

Your President-Elect believes that in physiology, as in other branches of science, there will be an increasing need for men who can put ideas together effectively and write well. These will not be a new breed of scientist. They are no one else but ourselves. Those of us who are able to do so should expect to give an increasing fraction of time to the preparation of synthetic papers and critical digests of information, perhaps in different form for different audiences. Because of the great increase in the total amount of scientific data and the number of papers published, every scientist must more and more depend on others to perform such critical evaluation and to make the digests. But in his own personal fields of specialization he must perform the function for others. It is only the specialist in a field who often goes to the original data. Others must depend on the interplay of a few specialists for the origination, the formulation and criticism of the ideas that emerge from the data in that area.

In writing the routine report of experiments it is a duty of everyone to at least "put solid handles on his data" by expressing them clearly and precisely and by showing where they fit into the scheme of things. Each paper should be adequately titled and effectively abstracted, so that it may be efficiently and fully indexed. Only then can the information subsequently be retrieved by automatic means. Furthermore the author should indicate near the beginning of a paper just what he believes to be the new or unique contribution.

In every group discussion on the tour we considered the proposal offered at the Iowa meeting by Dr. Visscher, Chairman of the Board of Publication Trustees, to establish a new journal or a section of AJP devoted to the quick publication of short papers that are essentially progress reports. He had suggested also that members of the society might be given the privilege of publishing one or perhaps two such papers per annum without editorial review. This new avenue of publication might relieve pressure on AJP and allow space for the desired "idea papers."

Overall opinion as to the desirability of such a new "reports journal" was divided. Many supported it, but usually with reservations, and there were a number of caustic opponents. However, few believed that it would materially relieve pressure on AJP. It would probably only encourage additional "bit" publication. Some liked the idea of prompt publication very much, but few cared for the proposal of freedom from editorial review. The ten-minute paper and its abstract seem to provide all the freedom of speech that our members really want. Nearly everyone expected that the prestige of such a journal would be less than that of AJP and JAP, even with the retention of some editorial control, and many members fear to injure the present journals by too close an association with such an innovation. This consideration outweighed the alternative view that incorporation of "progress reports" in AJP would make them "respectable."

Two generally accepted advantages of a "progress report" type of publication are 1) better assignment of credit to junior authors who are associated with a major project for only a year or less, and 2) less danger of burying information that is not adequately indicated by the title. The danger of burial will obviously increase as more dependence is placed in the future on coding and automatized retrieval of information. Neither of these advantages was often considered of overriding importance, however.

Without going into the numerous arguments pro and con, suffice it that your President-Elect was finally swayed on this issue by the more conservative (usually the older) members. He has recommended to the Board of Publication Trustees that they should not at present initiate a new journal for brief reports but should experiment first with certain other alternatives that have been suggested for improvement and relief of the American Journal of Physiology, and to try to improve the quality of manuscripts at the source. They should at least wait until THE PHYSIOLOGIST is firmly established before launching into still another publication venture.

With some trepidation your President-Elect introduced the subject of a page charge for AJP and JAP as a possible future innovation when the pressure of increasing publication costs becomes too severe. The idea of a page charge, set high enough to balance the budget with moderate subscription rates, seemed to be perfectly acceptable to every group, although there were a few vigorous dissenters. The basis of dissent was almost always the possibility that financial considerations might hinder scientific publication. Some individuals are still working without adequate financial support. Practically all members were willing to accept the principle of a page charge if it could be "passed on" to the granting agencies that now support so much of our research, and with the exemption of the author who has no funds available for such purposes. (This principle is now being used successfully by the American Institute of Physics.) A popular formula was "if an agency wants its name published in a footnote as sponsor of a research it should pay for this privilege."

The alternative of higher and higher subscription prices of all APS publications was definitely unpopular. Only one member stated explicitly that he believed that the burden should be placed squarely on the libraries—which presumably would have to obtain government or foundation support. Several suggested that the solution might be government or foundation assistance to the journals. Advertising was sometimes suggested, but those suggesting it seemed not to realize the well-established fact that archival journals like AJP and JAP are not attractive to advertisers, although house organs like THE PHYSIOLOGIST and those programs of meetings and exhibits like Federation Proceedings have a strong appeal.

Two alternative forms of relief for AJP were suggested. The first was a more rigorous editorial policy. Our present papers are in general first class, but some are weak and could to advantage be condensed into two- or three-page progress reports, or else withheld until more conclusive or extensive results are obtained. The second was sectioning AJP so that members can subscribe to the part that interests them most without having to buy, and then store, the entire journal. Members would be willing to pay nearly as much for a section as they now pay for the whole journal. The idea of sectioning seems rather popular provided, a) the sections be large enough to absorb shifts of interest and activity from one 5-year period to another; b) the sections be approximately equal in size and probably prestige; c) a formula can be found for distributing or grouping the "odd" papers ("no one is willing to have his paper in a 'miscellaneous' section"); d) the tables of contents of all sections always be printed in each section.

Your President-Elect extends his thanks to the members for their thoughtful suggestions and comments and for their keen and extended discussions that he enjoyed during the course of his tour. He hopes that this report conveys a fair impression of the "grass roots sentiment" of the Society which he was commissioned to sample and assess for the benefit of the Council and the Board of Publication Trustees.

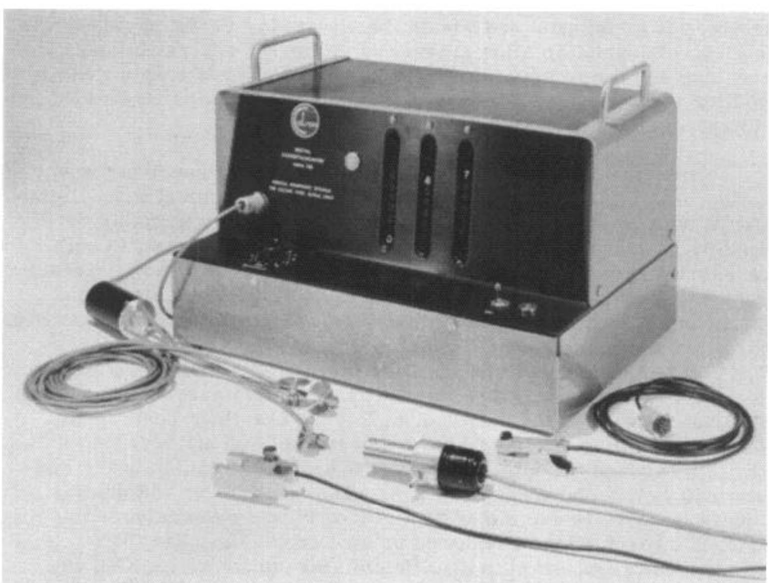
NEW INSTRUMENTS FOR PHYSIOLOGISTS

By Alfred Henley

National Instrument Laboratories, Inc.
Washington, D. C.

It is a curious fact of instrumentation in our field that techniques and equipment new for us often originate in industrial laboratories entirely remote from physiology. This accidental "method" of discovery is unfortunate. The time is past due when the carry-over of new ideas and appliances from industry to medical and physiological research should be made systematic and thorough.

Several of the instruments briefly described below are good examples of the random manner in which some excellent apparatus has been borrowed from aviation, industry and electronics. All of the units are now commercially available but have been exhibited in final produc tion form only in the past month. All have sound histories of invention and trial use by leading research laboratories and individual investigators, whose names are given wherever they are known.



Digital Cardiotachometer. To the writer's knowledge this is the only instrument of this type to offer true linear scale pulse rate presentation over a wide range in both numerical and proportional form. The full range of pulse rate in man and most animals can be picked up from one of a variety of attachments and displayed or recorded. Signals varying cyclically are picked up from the ear, finger, ECG or blood pressure cuff. The time interval, t, between successive cycles is continuously measured. Since pulse rate,

$$P.R. = \frac{1}{t}$$

the quantity $\frac{1}{t}$ must be calculated. A built-in computer circuit instantaneously computes and displays this quantity. The instrument follows changes without lag, uses no clicking relays to distract the subject, and is accurate within 2% of full scale.

Stereotaxic Instrument. With features of greater flexibility than many complex and more expensive stereotaxic equipment for the rat the Stellar-Johnson apparatus possesses minimal superstructure to get in the way of the operator. The entire electrode assembly can be swung away from the animal's head to give a completely clear field for work. All the manipulating knobs are large and accessible but unobtrusive, the scales being placed so as to be easily read from the left of the instrument. The electrode chuck is adaptable to any practical electrode size and can be easily released for implantations of electrodes. The attachment for making electrical contact with the skull permits the operator to work with the skull level or tilted over any angle. Perhaps the most important feature of all is the automatic zeroing device for the angular approach of the electrode, provided by two vertical adjustments, one on the post and one on the electrode. Seven ranges in the degrees of angulation allow traverse to different superstructures in reaching any target area within the brain and affords easy access to midline structures, since the sagittal sinus can always be avoided by coming in at a left or right angle.

Bird Residual Breather. The oxygen demand regulator is an indispensable piece of equipment for all pilots on high altitude flights. Dating back to World War II, this device has been remarkably developed by its manufacturer for applications of great interest to both research and clinical physiologists. Although the unit is being studied for performance data in several centers of respiratory research throughout the country, considerable preliminary information has been compiled at the District of Columbia General Hospital, Washington, D. C. It has been found that the Bird valve offers less resistance to demand breathing than other intermittent positive pressure breathing apparatus, owing to the unique design of the breathing control unit. The flow of air is governed by the movement of an air bearing which shuttles between two adjustable magnet systems, regulating the end-inspiratory and end-expiratory pressures. Automatic and manual timers suggest its use either as a self-cycling resuscitator where artificial respiration is required or as a respiratory aid where spontaneous respiration is insufficient. Should the anticipated performance of this device be fulfilled, the respiratory physiologist and clinician interested in the pulmonary involvement of cardiac and other pathological conditions may find innumerable applications of great value. The sound engineering packed into its compact and streamlined form deserves special mention.

Computing Spirometer. In evaluating Maximum Breathing Capacity, Vital Capacity, and Timed Vital Capacity the investigator is confronted with the expense, inconvenience and time-consuming interpretation of records. An advanced spirometer development adapting new digital computer techniques to the problems of pulmonary function testing instantaneously computes MBC and TVC values. The basic elements of the system are a Krogh type spirometer of special construction utilizing anti-friction bearings and a non-contacting optical-electronic pickup unit. Movement of the spirometer bell is converted into electrical pulses by a mask containing opaque lines spaced to intercept a light beam each time the bell moves the equivalent of 50 milliliters volume. The pulses are counted by an electronic and electro-mechanical counter to give the total volume change during a timed interval. A rebreathing bag may be installed to permit simultaneous registration of rinsing curves using N_2 or He_2. An attachment will be available for measurement of maximum expiratory flow rate.

Pulse Monitor and Warning System. Although most useful in operating and recovery rooms, this monitor is also applicable in research laboratories in which rapid and accurate blood pressure determinations are to be made on rats, dogs, monkeys and other animals. The portable unit—it weighs only five pounds—bears two large meters, one of which gives continuous indication of changes in pulse strength and the other pulse rate in beats per minute. An audible warning is given when there is a critical fall in the patient's pulse strength or when the pulse rate exceeds a pre-set level, a small neon light between the meters flashing with each pulse beat.

A.M.I. Integrator and Timing System. Designed for use with standard oscillograph recorders such as EEG's and EMG's, the Allen Memorial Institute at McGill University has developed a new and interesting measuring system to meet instrumentation requirements of psycho-physiological investigators. The system offers calibrated electronic integrators, timers and synchronizing units in an expanding building-block network which grows with experimental (and budget) progress. Integrator and timing systems can be connected to the output of any balanced bridge transducer circuit, such as strain gauges for pressure, strain thermometers for temperature, and potentiometers for linear or angular displacement. Accordingly, these systems are significant for long-term muscle control studies, short-term muscle dynamics, muscle potential studies, tracking tasks, steadiness tests, mirror drawing and other performance tasks. As anyone who has done it knows, the method of measuring EMG potentials by hand is a most laborious procedure. The A.M.I. integrator and timing system performs a large part of the data reduction by electronic means.

Haldane Blood-Gas Apparatus. A technique for determining oxygen capacity and oxygen saturation in blood, widely used in Great Britain and continental Europe and regarded by many there as superior to the Van Slyke procedures, has now been incorporated in an instrument produced in the U. S. Both pilot and production models have been tested at D. C. General Hospital (Washington, D. C.) laboratories for more than a year. It was found that double check determinations of O_2 capacity, O_2 content, and O_2 saturation can be made in one procedure (as against 4 separate analyses by the Van Slyke method) with complete results in only 30 minutes. Blood obtained anaerobically is shaken in a closed system containing air. Released CO_2 is absorbed by an alkaline buffer solution. The uptake of O_2 by the blood to 100% saturation results in a reduction of the gas volume in the closed system, which is measured and read on a calibrated capillary. The blood is then hemolyzed with saponin and converted to methemoglobin by ferricyanide, which will cause a release of the O_2 previously combined with hemoglobin. The resultant increase of volume is measured and read on the capillary and represents the O_2 capacity. This value minus the first reading must be corrected for dissolved O_2 and N_2. Both readings are corrected to STPD. The oxyhemoglobin saturation is determined by the effective oxyhemoglobin content divided by the capacity multiplied by 100.

Address a post card to New Instruments for Physiologists, American Physiological Society, 9650 Wisconsin Avenue, Washington 14, D. C., for further information about any item described above.

THE PHYSIOLOGICAL DOCTOR WATSON

By Edward J. Van Liere

Since I am a professional physiologist references made to physiologic matters by Sir Arthur Conan Doyle in his delightful stories of Sherlock Holmes and Dr. Watson are of especial interest to me. Unfortunately there are not as many allusions to physiology as I would like, but those that are made are worthy of our attention.

A. Conan Doyle studied medicine at the University of Edinburgh; he enrolled in 1876 and was graduated in 1881. It will be remembered that physiology was first recognized as an essential and integral part of the medical curriculum when a "Chair of the Institutes of Medicine" was established at the University of Edinburgh in 1726. During the next one hundred and seventy-five years chairs of physiology, not only in Scottish universities, but in those of the Dominions were designated as "Chairs of the Institutes of Medicine."

About a year or two before young Doyle entered medical school, the professor of the Institutes of Medicine, that is, the professor of physiology, Hughes Bennet, had retired on account of ill health. It was he who popularized the medicinal use of cod liver oil. William Rutherford, who had been assistant to Professor Bennet, was elevated to the chair of physiology. Rutherford had spent a year on the continent and had studied in Berlin, Paris and Vienna – all great medical centers. When appointed he did not serve as professor of clinical medicine in the Royal Infirmary, as had his predecessors, but devoted his entire time to teaching and research.

Professor Rutherford was a brilliant experimentalist and was the first man in Edinburgh to demonstrate a number of physiologic phenomena, such as the determination of blood pressure, and the innervations of the heart. He was furthermore an extremely able lecturer, and often from four hundred to five hundred students attended his classes. It was said that when lecturing he was accustomed to walk up and down before his class with his eyes closed. (Parenthetically it is of interest that Doyle used Rutherford as the model for Professor Challenger in "The Lost World.")

We may assume that the young Doyle received good basic training in physiology – at any rate he apparently had a healthy respect for this important science. Let us examine the references he makes to physiological matters in his stories of Sherlock Holmes.

Physiologists Themselves

In "The Adventure of the Creeping Man" a professor of physiology, Presbury, is the central figure. Doyle speaks of him as a renowned "Camford" physiologist. The word "Camford" is a happy choice. It strikes one that it could be a combination of two words, Cambridge and Oxford. Whether Sir Arthur had these two famous schools in mind I cannot say, but I am inclined to believe he did. It is noteworthy that he depicts Professor Presbury as a wealthy man.

On one occasion Sherlock Holmes and Doctor Watson called at Presbury's home. The good doctor wrote glowingly about the physiologist's charming house and beautiful grounds, and emphasized that the professor was surrounded with every sign of luxury.

This is truly an unusual picture, for not many professional physiologists are wealthy, and they certainly are not surrounded with luxury. Professor Presbury fortunately was an exception. He must have been a wealthy man in his own right, or have married a woman of means, for surely he did not become wealthy teaching physiology.

Professor Presbury's assistant, Mr. Trevor Bennett, is interestingly pictured as a handsome, tall, young man and elegantly dressed. He was portrayed as having the shyness of the student, rather than the self-possession of a man of the world. We can readily understand his shyness and his studious manner, but it is more difficult to imagine his elegant appearance. Bennett, we later find, had a medical degree, so perhaps he had a consulting clinical practice which might account for his exceptionally groomed and elegant appearance.

Mr. Bennett's careful grooming is in contrast to the usual situation because physiologists, I fear, do not have the reputation for being well-dressed people. They are apt to be somewhat indifferent about their personal appearance, especially when at work in the laboratory. This is quite understandable since they often work with animals under conditions not conducive to maximum cleanliness. Some of the more fastidious scientists don old clothes for such occasions, but this is not always convenient. At any rate the average physiologist is not known for his elegant appearance, and for good measure I will throw in the pharmacologists also. Several living examples of each could be cited to prove my point, but I must refrain from embarrassing my distinguished friends and colleagues. At least Mr. Bennett may be considered an exception.

The fact that the name of Professor Presbury's assistant was Bennett is of interest to us. One wonders whether Sir Arthur deliberately or unconsciously named him after Professor Bennet, who was emeritus professor of physiology at the University of Edinburgh in Doyle's time. In this connection it is noteworthy that Sir Arthur did not use the name Bennet for the principal character in the story, " The Adventure of the Creeping Man." Although Presbury is depicted as brilliant, he is portrayed also as an eccentric and unfortunate individual. The eminent professor emeritus might well have taken offense had Doyle used the name of Bennett, and one may rest assured that Sir Arthur would not willingly have hurt his feelings.

Endocrinology

In the story mentioned above the author uses the theme of endocrinology. Professor Presbury, a widower in his early sixties, had fallen madly in love with a very young girl. In his desire to regain his lost youth the professor administered, to himself, injections of serum prepared from apes. A conniving Prague scientist had prepared the material from a langur, which Doyle dramatically described as one of the higher apes, distinguished by a black face and an inhabitant of the slopes of the Himalayas.

According to the story the serum had a profound effect on the professor. Following the serum injections, which he took at nine-day intervals, he acquired the characteristics of an ape, not only by simulating the mode of locomotion of this animal, but by developing also an uncanny ability to climb.

One night following a serum injection the professor got into grave difficulty when his heretofore faithful wolfhound, Roy, which he was bedeviling, attacked him viciously. As Sherlock Holmes told Dr. Watson the wolfhound thought he was attacking the monkey, and not his master, the professor. Presbury was saved by the quick action of Holmes and Watson.

The plot is fantastic, but interestingly told. Today this story would be regarded as science fiction. It was written at a time when the subject of rejuvenescence had been made popular by the endocrine studies of Steinach and of Voronoff, the European scientists. The father of endocrinological studies was, of course, Charles Edouard Brown-Sequard, who had reported his studies on testicular extracts in 1889 — about fourteen years before Doyle published his story. Doyle was undoubtedly familiar with Brown-Sequard's work. In "The Adventure of the Creeping Man" Sir Arthur points out a typically Victorian moral when he has Holmes remark to Watson that if one leaves the straight road to destiny even the highest type man may revert to the animal.

Mental Activity and Digestion

Sir Arthur obviously felt that one should eat sparingly if brain work is to be done. We find Dr. Watson saying that his friend, Holmes, had eaten no breakfast, because in his more intense moments he allowed himself no food. Holmes contended that he did not have energy to spare for both nerve force and digestion ("The Adventure of the Norwood Builder"). On another occasion Holmes, when talking to Dr. Watson emphasizes the fact that starvation refines the faculties. He insisted that during digestion the brain is robbed of blood, because blood is needed in the splanchnic area. Holmes insisted that he himself was a brain, and the rest of his body a mere appendix ("The Adventure of the Mazarin Stone").

The ideas expressed in the above paragraph hold our physiological interest, because at the time Doyle wrote the concept he expressed was the accepted one. Later work has shown that this theory is not tenable. It is generally accepted that mental work does not elevate the metabolism of the brain above the high level that obtains even when the mind is "idling." Holmes then would probably be in error in his idea that digestion, simply by the diversion of energy, could rob him of the ability to think.

It is claimed by some observers that the brain needs a slightly increased blood supply during lively mental activity, but not all physiologists accept these findings. Since metabolism is not increased by thought it would be surprising if much extra blood were necessary. In view of his circulatory system's powers of compensation, it could probably be assumed that Holmes' digestive processes did not embarrass the circulation to his brain. But again, the point is that Doyle put into his characters' mouths physiological words which rang true at the time.

A Weaker Sex?

Sir Arthur implies in one of his stories, "The Adventure of the Devil's Foot," that physiologically the female has a weaker constitution than the male. In this story it will be recalled that two men and one woman were exposed to the fumes of the "powdered devil's foot root." Doyle stated that only the woman was killed, presumably because she was the more sensitive. This is a challenging statement.

Considerable proof can be adduced to show that the female is hardier than the male. The old cliche, "the weaker sex," can be seriously questioned. It is well known, for example, that women can withstand a high blood pressure for years. In some instances, although by no means all, it seems to do them but little harm, since in spite of it they may live to a ripe old age. Hypertension in the male is generally a serious condition. The death rate from cardiovascular conditions is considerably higher in men of all ages than it is in women.

Recently it has been shown that female animals, such as rats, can withstand acute oxygen want far better than males. I do not wish to belabor the point that the female may be hardier than the male, but two more bits of evidence can be presented. Data compiled by life insurance companies definitely show that there are more widows in this country than widowers. Lastly, more boy babies die than girl babies. Other evidence could be cited, but the subject is a complex one, and it would not be profitable to consider it at length in this place. In fairness to Sir Arthur it must be stated that many of the facts just presented were not known when he wrote his entertaining, but gruesome story about the "devil's foot root."

Mental Development in the Young

We find in "The Adventure of the Sussex Vampire" an interesting and significant reference to mental development in the young. Holmes, speaking of a child, remarked in this story that the child probably had a very well developed mind, because his body had been circumscribed in action. Obviously a child who has a definite physical handicap cannot romp and play like other healthy, vigorous children. He is forced to find other outlets, and as a result probably reads a great deal, and is likely, moreover, to be thrown in with older people. As a consequence his mind presumably is more precociously trained than had he been able to lead the life of a healthy normal child. There are many physically handicapped children, and this entire matter deserves more critical psychological study than it has so far received.

Curare and Physiology

Sir Arthur was acquainted, at least to a degree, with the action of curare. Actually he used it as a lethal agent in two of his stories: in his novel, A Study in Scarlet, and in his short story, "The Adventure of the Sussex Vampire." In the former he was careless of the way he handled curare in his plot, for he ascribed actions to this drug which it simply does not possess. But in the latter instance he uses curare in a masterly manner. He points out, for example, that if a child were pricked with an arrow which had been dipped in a solution of curare, death might ensue by muscular paralysis if the curare were allowed to be absorbed. Incidentally this story can be recommended not only to physiologists and pharmacologists, but to all medical and biological students as well.

It is likely that Doyle became familiar with curare in his work in the physiology laboratory, for about twenty years before he enrolled in medical school, Claude Bernard, the famous French physiologist, had published his studies on curare.

Muscle Physiology

Let us now consider references to muscle physiology. Both Sherlock Holmes and Doctor Watson are portrayed as splendid athletes. In The Hound of the Baskervilles Watson wrote about their heroic efforts to save Sir Henry Baskerville from the awesome hound. He stated that he had never seen Holmes run as fast as he did that night. He remarked further that he (Watson) was reckoned fleet of foot, but Holmes easily outpaced him. In physiological parlance the muscles of Holmes and Watson presumably had short reflex times. Some men are born fast runners. The exact reason for this is not fully understood. Probably the entire neuromuscular apparatus, including the higher nervous centers, is implicated. Another factor is the mechanical advantage involved in the muscle-bone relationship. All these factors undoubtedly have to do with heredity. The entire picture is complicated. We do know, however, that training alone cannot produce champions.

In another instance we find Doctor Watson raising the question with Holmes as to why Sir Charles Baskerville's footprints showed that he was walking on tip toes before he dropped dead on the pathway between the old yew hedge. Holmes scouted this and tartly remarked to Watson that Sir Charles was running desperately for his life. It was known that he suffered from a weak heart, and the inference was, of course, that the tremendous physical exertion plus the shock of seeing the awesome hound brought about a fatal heart attack.

On another occasion Holmes described the gait of a man: " . . . he was running hard with occasional little springs, such as a weary man gives who is little accustomed to set any tax upon his legs" ("The Adventure of the Beryl Coronet"). On still another occasion we find an interesting reference to muscle physiology — one which only recently has been scientifically demonstrated. Holmes makes this pregnant remark in "The Man With the Twisted Lip":

> He is a cripple in the sense that he walks with a limp; but in other respects he appears to be a powerful and well nurtured man. Surely your medical experience will tell you, Watson, that weakness in one limb is often compensated for by exceptional strength in the other.

In summary, it has been shown that Sir Arthur Conan Doyle had a high regard for physiology, and was well cognizant of the principles underlying physiological processes. Since the time Sir Arthur studied physiology — nearly eighty years ago — there have, of course, been vast developments in this field of science. If he were writing his mystery stories today, these new discoveries would doubtless present to his imaginative mind fruitful sources for the weaving of ingenious and fascinating plots.

ANSWER TO PHYSIOLOGICAL CROSSWORD PUZZLE

1 C	2 O	U	R	3 N	4 A	5 N	6 D
7 A	V			8 A	W	A	Y
T		9 C	10 A	K	E		E
H		11 A	G	E		12 B	
13 E	14 E	G		15 D	16 R	I	17 P
18 T	R	E	19 E		20 A	T	P
21 E	G		22 C	Y	T	E	
23 R	O	C	K				