LONG ISLAND BIOLOGICAL ASSOCIATION

ANNUAL REPORT
OF
THE BIOLOGICAL LABORATORY

COLD SPRING HARBOR
LONG ISLAND, NEW YORK
1939

LONG ISLAND BIOLOGICAL ASSOCIATION

INCORPORATED 1924

ANNUAL REPORT

OF

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FIFTIETH YEAR

1939

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REPORT OF THE DIRECTOR

To the Officers and Members of the Long Island Biological Association:
Ladies and Gentlemen:

I have the honor to submit my report for the year 1939.

SYMPOSIUM

The subject of our annual Symposium on Quantitative Biology, the seventh of the series, was Biological Oxidations, and occupied the usual five-week period from June 20th to July 21st. A more timely subject could scarcely have been chosen, for it is one which is undergoing rapid development in many directions, and one which has come to be of the first importance in the investigation of cellular chemistry, whether physiological or abnormal. The subject was thoroughly covered in 34 papers presented by 35 authors, and read to audiences of the usual size, restricted to experts in the field and to people particularly interested in the subject. The papers, together with the edited discussions which followed them, will be published early in 1940 as Volume VII of the Cold Spring Harbor Symposia, with the title "Biological Oxidations"; in size, the volume will be about the same as last year's, and the discussions are, if anything, somewhat more lively than usual.

Inquiry will show, I think, that the conditions under which the Symposia are conducted at the present time are just about ideal, and that in conducting them the Laboratory is rendering a great service to biological science. It is difficult for us to realize that only a hundred years ago there was practically no 'biological literature' in the sense in which we use the term nowadays; very few biological journals have been in existence as long as that, and comparatively few even half as long. In the early days, knowledge was passed on largely from master to pupil, and the printed vehicle was the textbook, such as Haller's Textbook of 1777 or Schafer's Textbook of 1900, and not the Journal as we now know it. It is only since the latter part of the 1800's that the increasing amount of research has rendered necessary a corresponding increase in the number, and the size, of the journals which contain it, and an investigator does not take long to learn that the multiplicity of journals and reports of original work has become so great that he cannot hope to do more than cover the papers in his own narrow field of research. To keep himself acquainted with a field a little larger, he relies upon the abstract journals and the reviews; the rest, of necessity, he must let go, and he knows, of course, that this is a very unsatisfactory state of affairs.

It is primarily for this reason that Symposia have become essential in the biological and natural sciences. They stand at the head of an ascending scale; first there is the original paper, then the abstract journal which groups original papers together and summarizes them without criticism, then the review in which the literature on a single subject is brought together and evaluated by one expert reviewer, and finally the symposium, where the advances and conclusions in many related subjects are considered by many experts, not always in agreement, from many

points of view. The least a symposium can do is to give workers in other fields a means of keeping in touch with the results and trends of contemporaneous research, but it should do more than this. "The frank exchange of opinions and the exposition of facts upon which they are founded serve to re-energize us, even if like opposite charges they outwardly seem to repel. As no effective electrical forces can exist without positive and negative charges, so no dynamic forces can be induced in research without a polarity of opinion. Further, we who frequently become dissatisfied with our own contributions need to revitalize our faith occasionally by noting that the summation of modest efforts has contributed quite as much to progress as the occasional big discoveries."

The subject of the Symposium to be held during the summer of 1940 is Permeability and the Nature of Cell Membranes, and once more this subject has been selected partly because of the trend of the discussions at previous Symposia. During the last 15 or 20 years an enormous amount of work has been done in this field, but it is only recently that the conclusions of the many investigations have begun to take definite form. This is principally due to the introduction of new methods in the past few years, and it is upon this modern point of view that I would like to place emphasis, rather than trying to make a mere compendium of the observations in the field. The Rockefeller Foundation has again renewed its generous grant in support of the Symposia, and the meetings this summer will begin about June 25th and go on for the usual five weeks. The programs will be ready for distribution about the middle of May, and, judging from the list of those who have already said that they can take part, will contain the names of most of the prominent American investigators in the field.

This year only one little innovation was made in the conduct of the Symposium, and that was to devote one session to the demonstration of special methods. Dr. Summerson showed his differential manometers, Dr. Mueller his dropping mercury electrode, and Drs. Hogness, Shorr, Melnick, and Stern described and illustrated special apparatus used in their researches. Next year it may be possible to extend the idea to include demonstrations of the work being done in the laboratories.

RESEARCH

Passing to a report on the research work done during the summer, you will remember that the Rockefeller Foundation grant of $10,000 was divided, both in 1938 and in 1939, so that $7,000 would be applied to the cost of the Symposium itself, while the remainder would make it possible for us to have a limited number of selected investigators living at the Laboratory to carry out cooperative investigations.

I may say at the outset that this plan has met with certain difficulties, principally for two reasons. The first is that success in a cooperative experiment of this kind depends largely on the investigators being able to stay at the Laboratory for a considerable length of time, preferably about three months. In many cases this was found to be impracticable

because the people concerned had other plans or obligations, such as visiting abroad or teaching. The second is that the research work which can be done at the Laboratory even during a three months period often involves the shipping of special apparatus, and quite a number of Symposium participants, who would otherwise have been glad to work here, have found that dismantling their apparatus in their own laboratories and sending it here was too great an inconvenience and would waste a lot of time at both ends.

As a result we have had to compromise, and to select, during last summer as in the summer of 1938, investigators who were able to stay here for some months and for whose work we had or could get the necessary apparatus and materials, and who were anxious to work out problems with each other. In about half of these cases the investigators had taken part in one or another of the Cold Spring Harbor Symposia; the remaining investigators were selected on the basis of their having problems which could readily be worked out in collaboration with others. Using part of the Rockefeller Foundation grant for the purpose, as well as additional Laboratory funds, we were usually able to give free laboratory space, free rental and board, and to supply materials and animals free of charge.

The amount of work which can be done during a few months in the summer at an institution such as this is a matter upon which people are not altogether agreed. One school of thought believes that moving to a summer laboratory is apt to be a waste of the investigator's time, and that results can be expected only from full-time work in universities or research institutions. Others hold an entirely opposite view, and believe that cooperative research, or, to borrow a term from another field, "occasional" research, even though it may not last very long and though it may give rise to nothing more substantial than problems which have to be "taken home" to finish, is one of the most stimulating experiences a research worker can have. Those who hold the latter view at least have the history of the development of biology to back them up, and I dare say that if one could step a hundred years into the future and assess these things properly, one would find that the contribution made to the advance of biology by laboratories such as the Marine Biological Laboratory at Woods Hole, the Marine Laboratory at Plymouth, the Zoological Station at Naples, and other similar institutions, could properly be set beside the contribution made by the universities. I have become convinced that this Laboratory will serve biology well if we follow the general policy which has been adopted at Woods Hole, Plymouth, Naples, and other experimental stations of the same kind, and, so far as our contribution to research goes, I think that it is interesting to list the accomplishments which have resulted from cooperative investigation during the summers of 1938 and 1939. For 1938 the record is a more or less complete one, and the following Table, with its accompanying references, shows the nature of the investigations and the workers engaged on them.

TABLE I

GROUP	INVESTIGATORS	SUBJECTS	PUBLICATIONS
Electrokinetic phenomena (1938)	Dr. Harold A. Abramson Dr. Manuel Gorin Dr. Laurence S. Moyer Dr. Janet G. Daniel Mr. Robert Furchgott Mr. Arnold Sookne	Skin permeability. Mobility of red cells and ghosts. Surfaces of amino acids. Properties of ragweed pollen protein. Study of pores in skin. Electrical mobility of hemoglobin. Heights and areas of wheals in human skin. Electrophoresis of epinephrin.	8 papers References 1—8
Endocrinology (1938)	Dr. Hans O. Haterius Dr. Warren O. Nelson Dr. Robert Gaunt Dr. Hermann Rahn Dr. C. Donnell Turner	Cortical hormone-like action of progesterone. Adrenal cortex and diabetes insipidus. Lactation in rats. Uterine distention and maintenance of pregnancy. Transplantation of suprarenal glands. Placenta and corpus luteum in snakes.	6 papers References 9—14
Permeability (1938)	Dr. Harold F. Blum Dr. Hugh Davson Dr. J. F. Danielli Mr. Robert Furchgott Dr. F. R. Steggerda	Photodynamic hemolysis. Surface films. Cation permeability of ghosts and red cells. Surface changes in mammalian red cells. Potentials of frog skin in vivo.	7 papers References 15—21

REFERENCES FOR TABLE I

1. Relationship of skin permeability to electrophoresis of biologically active materials. Abramson and Gorin, J. Phys. Chem., 43, 3, 1939.
2. The electrophoretic mobility of rabbit erythrocytes and ghosts. Abramson, Furchgott and Ponder, J. Gen. Physiol., 22, 545, 1939.
3. The polar groups of protein and amino acid surfaces. Abramson, Gorin and Moyer, Chem. Rev., 24, 2, 1939.
4. Inactivity of pollen extracts by adsorption, and electrical charge of the resultant surface. Abramson, Sookne and Moyer, J. Allergy, 10, 317, 1939.
5. Electrophoresis of epinephrin. H. A. Abramson, Proc. Soc. Exp. Biol. and Med., 41, 375, 1939.
6. Electrophoretic demonstration of patent pores of the living human skin. Abramson and Gorin, J. Exp. Med., in press.
7. An improved method for recording the heights and areas of wheals in human skin. Abramson and Laury, J. Lab. and Clin. Med., in press.
8. The effect of phosphate buffers on the electrical mobility of hemoglobin. Abramson, Gorin and Moyer, J. Am. Chem. Soc., in press.
9. Uterine distension and maintenance of pregnancy in the oophorectomized rat. Haterius and Kempner, Proc. Soc. Exp. Biol. and Med., 42, 322, 1939.
10. Cortical hormone-like action of progesterone and non-effect of sex hormones on water intoxication. Gaunt, Nelson and Loomis, Proc. Soc. Exp. Biol. and Med., 39, 319, 1938.
11. Adrenal cortex and diabetes insipidus. Schweitzer, Gaunt, Nelson and Loomis, Anat. Rec., 72, 122, 1938.
12. The inhibition of lactation in the rat. Edelmann and Gaunt, Am. J. Physiol., in press.
13. Homotransplantation of suprarenal glands from prepuberal rats into the eyes of adults hosts. C. D. Turner, Anat. Rec., 73, 145, 1939.
14. Structure and function of placenta and corpus luteum in viviparous snakes. H. Rahn, Proc. Soc. Exp. Biol. and Med., 40, 381, 1939.
15. Photodynamic hemolysis. III. The percentage hemolysis curve. Blum and Morgan, J. Cell. and Comp. Physiol., 13, 269, 1939.
16. Photodynamic hemolysis. IV. The effect of light intensity. Blum and Hyman, J. Cell. and Comp. Physiol., 13, 281, 1939.
17. Photodynamic hemolysis. V. The effect of concentrations of dye on hemolysis time. Blum and Hyman, J. Cell. and Comp. Physiol., 13, 287, 1939.
18. Studies on permeability of erythrocytes. VI. The effect of reducing salt concentration of the medium surrounding the cell. H. Davson, Biochem. J., 33, 389, 1939.
19. Oick-sphere transformations in the mammalian erythrocyte. R. F. Furchgott, J. Exp. Biol., in press.
20. The site of resistance to diffusion through the cell membrane and the role of partition coefficients. J. F. Danielli, J. Physiol., 96, 3P, 1939.
21. Relation of the nervous system to skin potentials of the intact frog. Steggerda and Ponder, Anat. Rec., 72, 106, 1938.

The record for the summer of 1939 is not yet complete, because publication of a paper nowadays takes from six months to a year, but the investigations are outlined in Table II, and their results in the reports by individual investigators on pages 24 to 36 of this Report.

TABLE II

INVESTIGATORS	SUBJECTS	PAPERS IN PREPARATION
Dr. Charles O. Warren Dr. William Summerson Dr. Sidney Velick	Metabolism of bone marrow. Respirometry of tissues in plasma. Metabolism of malaria-infected chicken cells. Metabolism of reticulocytes.	4
Dr. Harold A. Abramson Dr. Manuel Gorin Mr. Robert Furchgott	Theory of ionic conductance. Electrical mobility of proteins. Electrolytic conductance at high salt concentrations. Effect of orientation of cells on conductance. Adsorption of crystalbumin. Preparation and properties of stromatin.	6
Dr. Hugh Davson Mr. Chester Hyman (with Dr. Eric Ponder)	In vivo effects of hemolysins. Acceleration of lysis by straight-chain alcohols. Mechanism of photodynamic hemolysis. Repair of red cell membrane after lysis.	4
Mr. Nicholas Fugo Dr. Hans O. Haterius	Relaxation of pelvic ligaments inducted by progesterone.	1
Dr. Richard T. Cox	Theoretical investigations on effect of orientation on cell suspensions.	1

The subjects listed in these Tables are as varied as anyone need desire; 17 out of the 21 papers in Table I and 13 out of the 16 papers in preparation in Table II represent work done by two or more collaborators who ordinarily would not be working together, and of the total of 37 papers referred to, 24 are concerned with subjects closely related to or arising out of the Symposium for that year or for the year before. When one considers that this represents the work done by summer investigators only, I think that it shows quite clearly that our present policy of encouraging research work during the summer months is justified by results.

To complete the record, there ought to be added the research work done by investigators other than those referred to in Tables I and II, i. e., of all-year round investigators and their assistants, etc. This brings the

total for 1938 up to 37 papers at least; some of the work is still in preparation or unpublished. Similarly, the total number of papers in preparation for 1939 is at least 24, and probably more nearly 30. I do not wish to give the impression that I think that mere number of papers published is a reliable measure of the research activity of a laboratory or department, but, if only papers published in first-class journals are considered, it is at least a guide to what is going on. In the case of an institution such as this, it is probably a less reliable measure than usual, because so much of our contribution to research is indirect, by means of the Symposia, and otherwise.

INSTRUCTION

Last summer the Laboratory offered the same courses as during the summer of 1938 with the exception of Plant Ecology, which has been discontinued, and I am glad to say that my explanation of the small registration in 1938 as being due to a year of depression was correct. Last year we had a loss of $2,000 in Laboratory income because of the small number of students, whereas this year the income was about what it usually is.

The course in Surgical Methods was again given by Dr. George W. Corner of the University of Rochester School of Medicine, and I regret to say for the last time, because of Dr. Corner's new appointment as Director of the Department of Embryology of the Carnegie Institution of Washington. Dr. Corner's contribution to the teaching of Experimental Surgery at the Laboratory has been so great that it is difficult to think of the course going on without him, for his name has become so closely associaed with the course and with its excellence.

The surgery course was fully registered with 13 students, 8 of them being graduates and the same number either doing, or going to do, research and teaching. The course in Experimental Endocrinology was again instructed by Dr. H. O. Haterius of Wayne University College of Medicine with 6 students registered, and the course in Marine and Fresh Water Zoology, with a registration of 10 students, 5 of whom were graduates, was in charge of Dr. W. A. Castle and Dr. W. A. Dreyer. For further information about the courses I refer you to the reports of the instructors on pages 22 and 23.

Taken altogether, the summer courses are in a very satisfactory state, although the integration of the various types of work with each other and with the research program of the Laboratory is a field in which change and improvement must always be possible. This is a question which is being considered by a committee appointed by Mr. Page from the scientific members of the Board of Directors. As a matter of general policy, there does not seem to be any reason for the Laboratory to restrict the number of courses which it offers, provided that there is a demand for them, and either now or in the future it may be desirable to offer courses because particular investigators are working at the Laboratory and able to give them, rather than to repeat the same program from year to year. One development, for example, has been recommended

as a desirable addition to our activities within the next year or two: the Laboratory should offer a course either in general physiology, cellular physiology or experimental zoology. There is a demand for this kind of work, and it would fit in well with our general program. The backbone of the course could be made the same from year to year, consisting of fundamentals dealt with in lectures, and simple illustrative experiments, or repetitions of classical experiments, as laboratory work. More recent developments could be dealt with in seminars, and these might be different from year to year, perhaps depending on the Symposium subject. I think that until we do this, we will not be using our facilities to their full advantage.

OTHER SCIENTIFIC ACTIVITIES

A report on the Symposium, the research, and the classes conducted at the Laboratory covers its essential scientific work, but for some years I have felt that our activities ought not to end with these. In an institution such as this there is much to be said for a policy of "carpe diem" rather than a strict adherence to a program worked out in advance, and such unplanned events as a visit from a well-known scientist, the sudden development of interest in a particular problem among a small group, or the wider demand on the part of students and investigators to know what each other is doing, can all be turned to good account to add to the scientific background against which the more formal aspects of the Laboratory's work appear.

As part of this scientific background, it has been a tradition to arrange for "Evening Lectures", of general interest, on Tuesdays throughout the summer. These evening lectures have now become quite an institution, and are attended by capacity audiences made up of our own students, investigators, and guests, our neighbors at the Carnegie Institution, and visitors from the nearby hospitals. This year particularly we have gone out of our way to ask eminent scientists to speak, and we may congratulate ourselves that those who have been asked have responded so generously, especially as they often had to travel quite a distance.

EVENING LECTURES

June 20th.	Dr. Otto Rahn, Cornell University— "Oxygen as inhibiting factor in bacterial cultures."
June 23rd.	Dr. Richard T. Cox, New York University— "The electric eel."
June 27th.	Dr. George W. Corner, University of Rochester School of Medicine and Dentistry— "The reticulo-endothelial system from the histologist's standpoint."
June 30th.	Dr. Eric Ponder, The Biological Laboratory— "Recent advances in our knowledge of the structure of the red cell membrane."

July 7th. Dr. Hans O. Haterius, Wayne University College of Medicine—
"Hormonal control of diuresis."

July 11th. Dr. K. C. Blanchard, New York University—
"Intermolecular respiration, past and present."

July 18th. Dr. Hudson Hoagland, Clark University—
"Enzyme pacemakers and electrical brain wave frequencies."

August 1st. Dr. Robert C. Murphy, American Museum of Natural History—
"A recent reconnaissance along the Pacific coasts of Colombia and Ecuador."

August 8th. Dr. Harold A. Abramson, College of Physicians and Surgeons, Columbia University—
"Allergy and the physicist."

August 15th. Dr. C. B. Davenport, Carnegie Institution of Washington—
"The growing head."

August 22nd. Dr. Hugh Davson, University College, London—
"Permeability to ions."

Early in the summer Dr. G. L. Clark of the University of Illinois wrote me to say that Dr. Fritz Eirich of the Department of Colloid Science, Cambridge University, England, would be visiting this country on a lecture tour. Knowing Dr. Eirich's work, I asked him if he would give some of his lectures here, and this he very kindly consented to do. Fortunately he was able to give two of them before the Symposium ended, and the lectures with the discussions which followed them amounted to an informal seminar on high molecular compounds and the most recent developments in that field. Dr. Eirich intended to return to the Laboratory in order to discuss various research problems, but had to sail hurriedly to England because of the war.

LECTURES BY DR. FRITZ EIRICH

July 19th. Oxidation in monolayers.
July 21st. Serum reactions with colloidal tungstic oxide.
July 24th. High molecular compounds I.
July 26th. High molecular compounds II.
July 28th. High molecular compounds III.

During the latter half of the summer, after the Symposium was over, a discussion arose among several of the research workers on the subject of the properties of chemical bonds (a matter which had entered into some of the papers read at the Symposium). As we had working with us Professor Cox of the Physics Department at New York University, and also Dr. Manuel Gorin, an informal seminar on the subject was arranged, using Pauling's recent book "The Nature of the Chemical Bond" as a guide, and with Dr. Cox and Dr. Gorin undertaking the task of expounding it. I do not suppose that any of the auditors of this particular seminar will ever work on the nature of chem-

ical bonds, but the fact remains that they painlessly obtained an acquaintance, however slight, with a subject which they would probably never have encountered otherwise. Informal seminars and round-table discussions come into being naturally and spontaneously in a scientific colony such as ours, and, among their other virtues, cost nothing.

LIBRARY

As I remarked in my report last year, the problem of the library is a very difficult one. We do not have much money to spend, but we have been continuing our subscriptions to as many of the current journals in physiology, physics, and physical chemistry as we have found possible. A further difficulty is that we do not have sufficient space to house the steadily growing collection, and that the binding of current numbers and back volumes amounts to more and more each year. We have met the space difficulty temporarily by turning one of the small rooms on the second floor of the George Lane Nichols Memorial into a room for bound volumes of the journals, and this is certainly a great improvement over the previous state of affairs, because we are able to keep all our journals in a heated building. The alteration liberates space in the room which used to be our library, and which will now revert to its original purpose as a room for conferences and seminars.

Given that the amount of money and space available is small, our problem at the moment is to use them most wisely. It seems that we will do best if we specialize in taking the abstract journals, review journals, and recent monographs, together with building up our reprint collection, which now totals more than 24,000 reprints. These are sufficient to enable investigators to keep abreast of the literature, particularly as they can be supplemented by the library exchange service. Our present library is particularly weak as regards recent scientific monographs. These are being published nowadays in almost every field, and act very much like symposia in summarizing the present situation and giving complete lists of references to the literature. To the investigator working in fields where biology, physics and chemistry, and the other natural sciences meet, a few such monographs are worth many journals.

INSTITUTIONS REPRESENTED

The following institutions were represented last summer by students, investigators, or people taking part in the Symposium, who were actually in residence at the Laboratory.

Barnard College, Columbia University
Brooklyn College
Carnegie Institution of Washington
Clark University
College of Physicians and Surgeons, Columbia University
Columbia University
Cornell University Medical College
DePauw University
Duke University Hospital

Duke University School of Medicine
Fordham University
George Washington University
Harvard Medical School
Harvard University
Hopkins Marine Station, Stanford University
Johns Hopkins Medical School
Johns Hopkins University School of Hygiene and Public Health
Lebanon Valley College
Long Island College of Medicine
Long Island University
New Jersey College for Women, Rutgers University
New York Hospital
New York State College of Agriculture, Ithaca
New York University College of Arts and Sciences
New York University College of Medicine
New York University, Washington Square College
Northwestern University Medical School
Oxford University, England
Princeton University
Rockefeller Institute for Medical Research
Saint Lawrence University
Stanford University
State University of Iowa
Syracuse University
Teachers College, Columbia University
University of California
University of Chicago
University of Cincinnati
University of Colorado
University of London, England
University of Pittsburgh
University of Rochester
University of Rochester, School of Medicine and Dentistry
University of Wisconsin
University of Wisconsin, College of Agriculture
Wallace & Tiernan Co., Inc.
Washington College
Washington University School of Medicine
Wayne University College of Medicine
Wesleyan University
Yale University
Yale University School of Medicine

The extent of this list is to some degree a measure of the extent of the influence of the Laboratory, although it cannot show the extent to which current research and thought in the biological sciences is influenced by the Symposium papers and discussions, which are distributed to libraries and individuals in almost every country of the world.

LABORATORY BUILDINGS

Most of our laboratory buildings are in excellent condition, and comparatively few changes and additions have had to be made during the last year. Since Dr. Climenko and his staff have left the Wawepex Laboratory, we now have sufficient laboratory space for the use of summer investigators, at least for the time being. The members of the Association may be interested in a short summary of the scientific facilities with which the Laboratory begins its fifty-first year of service.

1. The George Lane Nichols Memorial, in addition to the administrative offices and three laboratories which are used all year, can accommodate four investigators in separate rooms. One wing of the building is used as a stockroom, and the other as a conference room. The laboratories are quite up to date, and are well equipped with apparatus and materials for research in general and quantitative biology.

2. The Walter B. James Laboratory for Biophysics can accommodate from four to six investigators, and contains the laboratory workshop. This building also is of modern construction, and is suitable for investigations in biophysics, biochemistry, or quantitative biology.

3. The Wawepex Laboratory was renovated about two years ago, and after some further alterations have been made will be quite suitable for investigators who do not require special apparatus other than that which can be transported from the stockroom. Even without using the upper floor, there is room for three or four investigators, each with a laboratory of his own. In the basement there is a large animal room provided with heat and used throughout the year.

4. The Davenport Laboratory is now used almost exclusively for teaching, and accommodates the class in Surgical Methods on the upper floor and the class in Experimental Endocrinology on the lower floor. As these classes are given in the first six weeks of the summer only, the space is available during the rest of the summer for individual investigators who are working on animal problems. For their convenience, as well as to supply animals for the courses, a properly laid-out animal room has been constructed in the basement.

5. The John D. Jones Laboratory. Two years ago this large hall was divided by partitions into six rooms, four of which are suitable for investigators who do not require much special apparatus, and two of which (the larger ones) are used for the class in Marine and Fresh Water Zoology. The building, with its peculiar construction, is rather like the original building of the Marine Laboratory at Plymouth, and, while in no sense a modern laboratory, is a very comfortable place in which to do work in connection with field investigations, etc. Large fresh water and sea water tanks run the length of the building, and the central part of it is sufficiently large to be used for lectures to small groups, such as the Marine and Fresh Water Zoology class.

Counting everything together, there is room for about 16 investigators, each with his own laboratory, and considering that each of these laboratories is large enough to accommodate at least one assistant or associate, the whole space is sufficient to take care of about 30 research

workers, without crowding, and at one time. While the individual laboratories are not equally modern, each is quite well adapted to its particular purpose.

During the year Mrs. Harris has been in charge of work on the houses and grounds, and she gives the following report of what has been done: "The early months of 1939 found us still salvaging hurricane lumber, which we used to heat our buildings. As the weather improved we started our annual painting, completing the outside work on Williams House. Blackford Hall had a much-needed new roof laid and all the wooden trim painted. We also graded and built a clothes yard and improved the road and drainage system. The House Committee, headed by Mrs. Percy Jennings, used their funds this year to install an asphalt tile floor in the game room of Blackford Hall. It is a beautiful floor. We have built several new paths with steps on the steep places around the buildings, and have eliminated the very unsightly garbage dump in the back of Williams House by continuing the road through the woods. The swampy place between Jones and Wawepex has been cleared out, and the overflow water from our well made to run into a little channel towards the harbor. Each apartment had its annual rejuvenation, but Stewart Cottage received the greatest attention this year, with new curtains throughout and many new furnishings which were the gifts of friends of the Laboratory."

As the result of the improvements of the last few years, the living accommodations can now be pronounced as being in good order. They are nevertheless severely taxed during the summer, especially during the Symposium period, when it seems almost impossible to find quarters for all the visitors who wish to stay.

The Women's Committee has continued to contribute money and furniture, and the Laboratory is under a special debt to Mrs. Merle-Smith and the officers of the Committee for the many ways in which they have helped us to meet problems relative to the houses and grounds.

The work of the Laboratory has been made possible only by the generous support of the Rockefeller Foundation, the Wawepex Society, the Carnegie Corporation, the officers and members of the Women's Committee, and by the many generous contributors in the neighborhood.

Respectfully submitted,

ERIC PONDER

REPORTS OF INSTRUCTORS

SURGICAL METHODS

The course in Surgical Methods had an enrollment of 13, of whom 4 were graduate students or other persons of advanced training, 9 college juniors and seniors majoring in biology and mostly intending to study medicine. The course was conducted very much as in previous years, and on the whole the work of the students compared very favorably with that of their predecessors. Mr. Richard Overman gave valuable service as assistant, and the class profited very much by demonstrations and talks given generously by several investigators, including Dr. Eric Ponder, Dr. Ernest W. Blanchard, Dr. Samuel R. M. Reynolds, and Dr. Hugh Davson. Dr. Haterius and Mr. Fugo of the staff of the course in Endocrinology not only gave demonstrations, but were constantly called upon for advice. Members of the class in Surgical Methods all regularly attended the lectures in Endocrinology, and the two courses were conducted as in previous years in close cooperation.

GEORGE W. CORNER

EXPERIMENTAL ENDOCRINOLOGY

As in previous years, the course in Experimental Endocrinology included daily lectures and laboratory work. The lectures dealt with the present status of our knowledge concerning the physiology of the endocrine system, with special reference to the pituitary complex, the sex hormones, the adrenal glands, together with discussion of the hormonal factors involved in water exchange and in carbohydrate metabolism. Laboratory work included the more fundamental experimental procedures used in preparation and care of test animals and in methods of bioassay, as well as the simpler histological techniques required in the study of endocrine activity in the experimental animal.

We are grateful for the profitable contributions to the course provided by Dr. Corner, of the staff in Surgical Methods, in his excellent lectures on certain phases of reproductive physiology. We are indebted also to Drs. S. B. Barker, of the Cornell University Medical School, R. W. Bates, of the Carnegie Institution of Washington, and Eric Ponder, Director of the Biological Laboratory, for their generous participation in discussing certain relevent physiological and chemical problems.

HANS O. HATERIUS

MARINE AND FRESH WATER ZOOLOGY

Twelve students were registered in the class in Marine and Fresh Water Zoology. Of these four were undergraduates, six were graduate students, and two were teachers. They represented schools scattered from Long Island to Colorado and Texas.

The work of the course was, as in previous years, centered around field trips. These included expeditions to twelve marine and eight fresh

water habitats. The trips were supplemented by laboratory studies of marine and fresh water plancton secured by towing. Animals collected were brought back to the laboratory for identification and study. Many forms were maintained in the laboratory for a period of time and were later used in experiments. Members of the class conducted experiments on toleration of marine animals for fresh water and of fresh water animals for marine water, choice of bottom, and chromatophoral responses. Opportunity was given in this part of the course for students to follow up their individual interests, with the result that some of the experiments were carried out in a complete and sometimes highly original manner. About a third of the time of the course was spent in the field and the remainder in the laboratory. Lectures were given about twice weekly and were interspersed by almost daily class conferences summarizing the results of field trips and experiments.

The work of the course was this year extended to include a study of certain environmental factors which influence the distribution of animals. Water temperature and pH were taken at most collecting stations. Samples of water from appropriate stations were titrated for free oxygen content by Winkler's method, and from marine stations the salinity was measured by Harvey's method for estimation of total chlorides. Interested students made a more complete analysis of water from the Inner Harbor from samples taken at different heights of the tide, as well as a study of conditions in the transition zone of Nautchaquatuck Creek.

The class as a whole was a congenial and enthusiastic group. The extent of this enthusiasm is evidenced by the fact that one group of students compiled a complete catalog of the books and reprints in the laboratory's working library that will be invaluable to the classes of future years. Most of the members of the class found time for one or more visits to the New York World's Fair. The class as a unit spent a day in the exhibits, preparation rooms, and experimental laboratories of the American Museum of Natural History.

WILLIAM A. CASTLE
WILLIAM A. DREYER

Dr. Harold A. Abramson's Report

College of Physicians and Surgeons, Columbia University,
and the Mount Sinai Hospital, New York

(1). Last summer (1938) grass and ragweed hay fevers were treated co-seasonally by the electrophoresis of extracts of these pollens. In the summer of 1939 a technic was developed which was utilized in the treatment of hay fever pre-seasonally by means of extracts of both short and giant ragweed pollens. Seven cases were treated in this way. The results were more than satisfactory. For, in spite of the fact that the method is new, a preliminary examination of the data show that the electrical method of vaccination seems to be as efficacious as the injection method. Further studies along this line are contemplated.

(2). With Mr. Roland Laury, the work of Miss Metz of the preceding summer was carried forward. Further development in the technic of studying the growth of allergic wheals may now be reported. The work of Miss Metz and Mr. Laury will serve as a basis for intensified research on water depots in the skin and for further analysis of the growth and decay of allergic and histamine wheals.

(3). The study of the electrophoresis of dyes in the living human skin was continued and further analysis of pore patterns was made. New dyes were employed and it was definitely shown that the contention of Rein is erroneous. Rein had maintained that only positive dyes can readily be introduced by electrophoresis into the skin. We were able to show that with our technic negative dyes also could readily be introduced.

At the suggestion of Dr. Ponder and in cooperation with him an analysis of the distribution of the patent pores of the living human skin was made on the body of a single individual. These pore patterns were obtained on the forehead, ear, anterior and posterior aspects of the torso, and various parts of the extremities. Certain variations in distribution were observed, and these studies will be continued next summer.

(4). The treatment of fungus infections of the skin has recently been advised by investigators at Yale, employing the electrical introduction of copper into the skin. We have studied the distribution of copper when introduced electrically into normal human skin and found that the copper is deposited in the pores in a fashion similar to that observed for dyes.

In collaboration with Dr. Yagoda, who has developed sensitized papers for detecting metallic ions, the electrophoresis of metallic ions was studied and beautiful pore prints of ions introduced electrically were obtained by reversed electrophoresis. In addition negative ions were also studied in a preliminary way.

(5.) Preliminary experiments on the nature of the electrical migration of the human spermatazoa have been begun. Because of the difficulty in obtaining suitable material these experiments were temporarily discontinued. The observations made on the nature of the migra-

tion of non-motile sperm in an electrical field was studied and found to be different than that previously reported. It is planned to continue these observations if suitable material is available, especially in connection with treatment of human sterility.

Dr. Hugh Davson's Report
University College, London, England

In collaboration with Dr. Ponder the investigations on the mechanism of photodynamic hemolysis begun last year were continued. It has been shown that photodynamic action on the rabbit erythrocyte membrane may be tentatively divided into three stages: (a) a stage of permeability of the erythrocyte to potassium; (b) a stage of permeability to both sodium and potassium; and (c) a stage of permeability to cations and also to hemoglobin. Cells in stage (a), when the source of light is removed, will continue to lose potassium but will otherwise be stable whereas cells in stage (b) will swell up as a result of a Donnan osmotic pressure difference and hemolyse; the time for this "after-light" hemolysis will depend on the number and size of the holes in the membrane caused by the photodynamic activity and may be of the order of hours. Cells in stage (c) will, of course, hemolyse during the illumination or within a few seconds of its cessation. This hypothesis accords with a variety of facts established by studies of cation permeability caused by photodynamic action and studies of the fading times of erythrocytes undergoing photodynamic lysis. The work is described in a forthcoming paper by Davson and Ponder in the Journal of Cellular and Comparative Physiology.

Dr. James A. de Tomasi's Report
New York State College of Agriculture, Ithaca, N. Y.

Preliminary studies on certain nuclear reactions of chromatin with rosanilin-pararosanilin dyes were carried out during the summer of 1939. Several organisms were used for obtaining plant and animal chromatin. It was found that most of the cells examined (from algae, Liliaceae, amphibia, fishes) yielded amounts of chromatic matter quite insufficient for the purpose of these studies. An important finding was, however, the fact that with the same dye, in at least one case in plants, the male nucleus in the pollen tube shortly before fertilization gives a distinctly different color reaction from that of the female nucleus in the egg cell.

Dr. Hugo Fricke's Report
The Biological Laboratory

A study was carried out on the dielectric properties of gelatin gels of low water contents. Earlier work on the action of X-rays on egg albumin and hemoglobin was extended to a study of reactions resulting from the direct activation of the protein molecules by the radiation.

Mr. Nicholas W. Fugo's Report
(John D. Jones Scholar)
State University of Iowa

In 1930 Hisaw and his collaborators described an alcohol-insoluble fraction from the corpus luteum of the ovary which possessed the specific capacity of causing relaxation of the guinea pig pubis. These workers called this substance "relaxin", and considered it to be distinct from the progestational fraction which they obtained in an ether-soluble form.

At the suggestion of Dr. Haterius I investigated the capability of the synthetically prepared corpus luteum hormone progesterone of causing relaxation of the pubic bones in castrated estrin-primed female guinea pigs. The synthetically prepared progesterone was kindly furnished to us by Dr. Schwenk of the Schering Corporation.

Fifteen adult female guinea pigs were castrated and treated with various doses of estrogen and progesterone or estrin alone. It was found that all animals receiving estrin-progesterone treatment showed relaxation while those receiving estrin alone remained unchanged.

A more complete account of this work has been published in the October issue of the Proceedings of the Society of Experimental Biology and Medicine, Volume 42.

Mr. Robert F. Furchgott's Report
(John D. Jones Scholar)
Northwestern University Medical School

Working during the past academic year in the Department of Chemistry of Northwestern University Medical School, I had found that mammalian red cells change from the discoidal to spherical shape if the pH of the suspension of cells is raised over 9.2 and if there has been previously removed from the suspension a substance ordinarily held by both serum and cells. This substance, which prevents sphering until a pH of about 11.3 is attained, had been named the "anti-sphering factor". The purpose of the work reported here was to determine the chemical nature of the factor and attempt to gain some insight as to the mechanism of its action, and a paper containing the results has been accepted for publication (Furchgott and Ponder, Journal of Experimental Biology).

The results of three different kinds of experiments led to the conclusion that the anti-sphering factor is the carbohydrate-poor fraction of serum albumin, also known as crystalbumin. One of these experiments also showed that cells, first freed of anti-sphering factor, when placed in a dilute solution of crystalbumin, take up about 0.8 g. of this substance per 100 cc. of cells.

To see whether the crystalbumin was acting at the surface of the cells, electrophoretic mobility measurements were made on cells variously treated with respect to factors involved in shape changes. It was found that cells with and without anti-sphering factor, cells with anti-sphering factor counteracted by fatty acids, and temporarily sphered ghosts, all

have the same electrophortic mobility in phosphate buffer of pH 7.4. In glycine buffer-NaCl solution of pH 10.1 cells with (smooth discs) and without (perfect spheres) anti-sphering factor or with the factor counteracted by fatty acids (perfect spheres) all have the same mobility. Also discoidal cells and cells sphered by lecithin have the same mobility in phosphate buffer-NaCl solution.

Report of Mr. Robert F. Furchgott and Mr. Ralf Brauer
Northwestern University Medical School and Columbia University

Preliminary experiments were carried out in an attempt to develop a method for the preparation of stromatin, the protein from the stroma of mammalian red cells. Rabbit cells were used. At first a try was made at following the procedure of Boehm, but inadequate cooling of the centrifuge made this unsuccessful. Preparations of ghosts were made by either freezing-and-thawing or hypotonic lysis, followed by a series of washings with CO_2-saturated water. It was found that such preparations could be dispersed in solutions of pH only slightly over 10, and that such dispersions remained stable on lowering the pH to neutrality. The work on the preparation of stroma protein is being continued by one of us (R. F. F.) at Northwestern University Medical School.

Dr. Manuel H. Gorin's Report

During the past year researches were continued along the several lines previously pursued at the Laboratory in the summer of 1938 (see Dr. Abramson's report). In addition, a new project was started and considerable progress has been made.

As an outgrowth of work (in collaboration with Drs. Abramson and Moyer) carried out at the Laboratory in the summer of 1938 on the theory of electrical mobility of proteins, a new approach to the theory of ionic conductance has been made (Journal of Chemical Physics).

The work on the theory of protein electric mobility has been continued. It is now possible to explain on an a priori basis, using only titration data and a knowledge of the size and asymmetry of the molecule, the mobility data in simple systems that are so far available. Or, conversely, the theory may be used to obtain from mobility and titration data for proteins information about the asymmetry of the molecule. The work was completed in time to be presented in the joint review article on protein surfaces with Drs. Abramson and Moyer in Chemical Reviews.

Further work in collaboration with Drs. Abramson and Moyer on the electric mobility of proteins has been recently completed and a manuscript sent to the Journal of the American Chemical Society. It was shown that the approach of Drs. Abramson and Moyer, heretofore restricted to simple buffer systems, applies to data recently published by Davis and Cohn for the electric mobility of hemoglobin in phosphate buffers containing the divalent anion HPO_4.

By an extension of the methods first applied to proteins and then to small ions (theory of ionic conductance), a more complete theoretical

investigation is under way, in which the approximations involved are being further restricted. The work has already progressed to the point of solution of the more difficult mathematical portions. Equations have been obtained which are of importance in the behavior of electrolytic conductance at high salt concentrations. Of more interest in biology, perhaps, is the fact that they predict minima in the activity coefficient-concentration curves at high salt concentrations, and it appears that for the first time some of the anomolies in the behavior of salt solutions at high concentrations may be explained. It is of special significance that the only possible approach to the problem of individual ion activities is the theoretical one.

Along the same line, the new equations are being applied to systems in which the anion and cation are greatly different in size. This problem is of interest in connection with liquid crystal formation in colloidal systems (coacervation).

A new project was initiated at the Laboratory this summer with Dr. Sidney Velick. The theory of Fricke for the conductance of suspensions of ellipsoids was extended to the more general case in which the three axes of the ellipse are different. The equations were applied to avian cells with success. Also, a conductance cell was designed for studying the effect of orientation on the conductance of the ellipsoidal cells. So far, the predicted effects of orientation have been qualitatively confirmed experimentally. A manuscript is in preparation.

The seminar on the nature of the chemical bond, in which I took part this summer at the Laboratory, stimulated and accelerated the collection of material for a monograph on the mechanism of chemical reactions.

Dr. A. J. Grout's Report
The Summer School of Bryology, Newfane, Vt.

Mrs. Inez M. Haring, unofficial investigator at Vassar College, spent the month of August at the School. This is her fourth summer. While she was there we were joined by Miss M. L. Wickes of the Huntington, New York, High School, a former student at the school, in a trip to Mt. Washington, N. H., to explore for mosses. Equipped with the proper permits, Mrs. Haring and I spent two days on the mountain and Miss Wickes nearly a week. A goodly number of rare and interesting species were found, but none not before reported.

Mr. Royce B. Hutchinson of the Clyde, Ohio, High School spent July and August with us studying the taxonomy of the mosses of the region in preparation for a thesis for a post graduate degree. He identified nearly two hundred mosses of the region, most of which he collected himself. He plans an ecological study of the mosses of the lake region of northern Ohio for his thesis.

It is of interest to note the progress of some of the previous students of the School.

Dr. Seville Flowers, who wrote a monograph of the Bartramiaceae for the Moss Flora of North American and whose accurate and artistic

drawings have been indispensable to the Flora, has been appointed to the Department of Botany of the University of Utah. He states that this appointment was greatly helped by his work on the Flora. Dr. Flowers was a University of Chicago Ph.D. before studying at Newfane.

Another Ph.D. student was Dr. Winona H. Welch of DePauw University. She has been acting head of the Department of Botany of that institution and has received a grant from a scientific foundation to study abroad for a season, which she spent in various of the principal herbaria at London, Paris, Berlin and Scandinavia in preparation for writing a world monograph of the Fontinalaceae. This would be the first such monograph to be attempted by an American bryologist.

Mr. A. J. Sharp later studied at Ohio State University and there obtained his Ph.D. After this he was appointed assistant professor at the University of Tennessee, where he is now located.

Dr. John E. Potzger of Butler University, another student already a Ph.D., has since written several ecological studies showing the importance of mosses in any study of plant relationships, and also several nature monographs for use in elementary and high schools.

Miss Geneva Sayre, just graduated from Grinnell College when she studied at Newfane, has recently obtained her Ph.D. from the University of Colorado and at last reports was teaching there.

In the summer of 1938 Miss M. L. Wickes spent a month or more exploring Labrador for mosses, paying her own expenses. She brought back many very interesting plants, including at least one species new to science. She has made up sets of 83 species of these mosses for distribution at $10.00 per set. These have been taken by some of the leading herbaria of the country.

In conclusion, Volume I of the Moss Flora, with index and keys, was completed with the issue of part 4 in July 1939. Volume II, part 4, with index, is partially in type and will be issued early in 1940, thus completing the work.

Mr. Mortimer J. Kempner's Report
Long Island College of Medicine

During the past summer, the results of the previous years experiments performed at the Biological Laboratory under the supervision of Dr. H. O. Haterius were gone over and a report written; this has since been published in the Proc. Soc. Exper. Biol. and Med., 43, 322. In addition, plans were made, techniques studied, and preliminary experiments performed, in order to continue the studies on the maintenance of pregnancy following oophorectomy in the rat.

The previous report mentioned a number of cases in which maintenance of uterine distension was thought to contribute to the preservation of pregnancy in the experimentally oophorectomized animal, and experiments are now being worked out for the study of the possible mechanism in which this distension may take part in the preservation

of the foetus. One of the methods being attempted is that of performing partial sympathectomy upon the rat, following somewhat the same technique as Bacq (Amer. Jour. Physiol., 99), and paying particular attention to the pelvic plexus. Following this we would have to repeat our previous experiments upon these animals. At the suggestion of Dr. S. R. M. Reynolds, another method is being worked on which involves mating, sympathectomy, removal of the fetuses and placenta by Caesarean section on the 14th day of pregnancy, distension of the uterus with paraffin, and studying the effect on the persistance of the corpora lutea in the animal.

The latter method necessitates the confirmation of the work of Selye (Proc. Soc. Exper. Biol. and Med., 31, 488), on the effect of uterine distension on the persistence of corpora lutea in the rat, but eliminates the hazards of having to keep a foetus alive in the uterus during the partial sympathectomy and distension with melted paraffin; it may reduce the number of negative results obtained. The experiments will, of necessity, take some time, but it is hoped that by means of one of the techniques described above to gather enough data for a report to be published in the spring.

Thanks are due to Dr. H. O. Haterius of Wayne University College of Medicine and to Dr. S. R. M. Reynolds of the Long Island College of Medicine for their aid in this series of experiments.

Mr. Richard R. Overman's Report
Harvard University

To determine the role of mitochondria in the secretion of the adrenal cortex of the albino mouse, adult males were injected with one Collip rat unit of adrenotropic factor from the anterior pituitary gland. The preparation used was Ayerst, McKenna, and Harrison's Growth Complex. This substance contains also about 10 R.U. of growth factor and an undetermined amount of prolactin, but since adult males were used, the effects of these factors was thought to have been minimized.

The cortical activity, as evidenced by the weight of the gland correlated with the proportional increase in the cortico-medullary width ratio, was greatest on the fifth day following the injection. The weights of the glands increased from 0.2 p. c. of the body weight to 0.6 p. c. by the fifth day after which there was a gradual return to normal.

Animals were killed with gas and the glands removed in two minutes and fixed in Regand's fixative and stained with Regand's hematoxylin after sectioning.

Indications are that there is a much greater fat deposition in the cortex than normally following this treatment. The mitochondria appear to have taken on more rod-like forms, some of which are swelled and beaded. There is a general increase in cell size in the cortex. The mitochondria are seen to congregate more on the capillary side of the cell.

Further work is in progress, using several other techniques to determine the validity of these observations. Colchicine treatment is also in

progress to determine the mitotic index of this tissue at various stages in the secretory cycle.

Dr. Ponder's Report
The Biological Laboratory

Most of my research this year has been concerned with problems which some years ago were left incompletely solved because of the lack of suitable methods, but which now can be profitably re-investigated.

1. The kinetics of acceleration. It is known that many substances produce acceleration of hemolysis by saponin and other chemical lysins, and the quantitative aspects of the acceleration were worked out in a general way as long as fifteen years ago. Over limited experimental ranges it appeared that the action of an accelerator is to increase the hemolytic power of the lysin a definite number of times, for example, to apparently double the strength of the lysin, triple its strength, etc. Recent investigations have shown that this is only an approximation to the true state of affairs, for if the experimental range is sufficiently increased it is apparent that the accelerators become less and less effective as the concentration of lysin becomes less and less. The accelerating effect accordingly depends upon the concentration of lysin present in the system, and is not constant.

Using saponin together with powerful accelerators, such as benzene, indol, and nonyl alcohol, the kinetics of the acceleration have been studied over much greater ranges of lysin concentration than heretofore. The action of the accelerator seems to be a peculiar one. In the first place, it itself attacks and alters the cell membrane to an extent proportional to its own concentration, and thus leaves the lysin with less work to do in order to bring about the complete breakdown of the cell. At the same time, however, it modifies the action of the lysin on the cell membrane, and this effect decreases with lysin concentration when the lysin concentration is below a certain critical value. These relations are of considerable interest in connection with the way in which a lysin may be supposed to effect the membrane component, and it must be confessed that at the moment their implications are far from clear. One important point, however, emerges; the accelerating effect of a substance is much smaller than one would expect when the quantities of lysin present are sublytic. In considering lysis in vivo, for example, it is customary to think of intravascular lysins being present in small quantities and their effects being enhanced under certain circumstances (perhaps in disease) by intravascular accelerators. It now begins to be doubtful whether this point of view is as sound as it once seemed to be, for these new observations imply that if the intravascular lysins were present in quantities insufficient to produce hemolysis, the accelerating effect of the intravascular accelerators would be correspondingly small.

2. The volume and behavior of ghosts. Until recently the methods for obtaining red cell ghosts (or envelopes, stromata, post-hemolytic residues, etc.) have been quite unsatisfactory, and much time

has been spent during the last year in working out a method for obtaining them in quantity. By hemolysing washed red cells with water and saturating with CO_2, the ghosts can be thrown down at moderate speeds of the centrifuge; by washing with CO_2 saturated water, they can be rendered almost hemoglobin free. They can then be suspended in isotonic salt solutions. Remarkably enough, these watery ghosts retain their discoidal form, and constitute material which makes possible a number of new lines of investigation bearing on the structure of the red cell and the nature of its membrane.

The first of these concerns the question of the permeability of the ghosts to various substances. Dr. Davson and I have already shown that they are slowly permeable to potassium, and Fricke and Curtis showed in 1934 that they can be considered as virtual non-conductors in an electrical field, which means that their permeability must be incomplete. It has long been known that watery ghosts are very difficult to free of their last traces of hemoglobin, even by prolonged washing, which means that they retain some of their pigment, either because their membranes are impermeable to it or because it is in some way bound to structures within the cell. This summer Miss L. C. Leavell carried out a large number of experiments on this "residual hemoglobin", and showed that its quantity depends on the quantity of water used to produce hemolysis and therefore on the concentration of hemoglobin in the surrounding fluid. The simplest explanation of these results is that some of the pigment is adsorbed by the material of which the ghost is composed. At the same time it can be shown that the membrane of the ghost is permeable to hemoglobin in the direction inside to outside, and also that it is permeable to hemoglobin in the direction outside to inside. This can be shown by a type of experiment in which hemoglobin is added to the fluid surrounding the cells and in which its concentration, which grows less if it permeates, is measured from time to time. To reconcile this permeability to not only potassium, but also to the large hemoglobin molecule, with the observation that the ghost behaves as a non-conductor in an electrical field, it can be supposed that the permeability exists at small regions of the membrane only. This would bring the phenomena of the permeability of the ghost into line with the view that lysis occurs because of the breakdown of small regions of the membrane, or the formation of "holes".

The second problem concerns the changes in volume which the ghosts undergo in solutions of various tonicities. Until recently there was no way of investigating this, but by applying conductivity methods it has been found possible to follow the volumes occupied by the ghosts as cells are hemolysed by hypotonic solutions and as the systems are made isotonic again. The principal result of these measurements is to show that, almost immediately after hemolysing, the ghost returns to the size of the normal red cell, and that if hypertonicity is established, a transient shrinkage is again followed by a return to the original volume. At the same time there is a return to the original shape, and the facts lead almost inescapably to the conclusion that the volume and shape of

the ghost is determined, in the absence of osmotic forces, by some structure within it. Such a structure is presumably present in the red cell also, and may be the jelly-like stroma or internal network postulated by some observers, or a highly organized surface structure.

3. Osmotic behavior of red cells. One of the most disputed points in connection with the mammalian red cell is the extent to which it swells in hypotonic solutions, some observers claiming that it behaves as a perfect osmometer and others claiming that it does not. The question is a fundamental one in connection with permeability phenomena, and at present the situation is completely baffling because the red cell appears to behave as a perfect osmometer under some circumstances, but as an imperfect one under others. This has not only been the result of experiments in this laboratory, but has been found by many investigators working under many different conditions. Unfortunately the factors which determine whether the cell behaves as a perfect osmometer or as an imperfect one are still unknown; injury to the cells, an excessive degree of hypotonicity, the use of certain anticoagulants, and several other factors, have all in turn been blamed for the strange behavior. A completely new set of experiments are now being carried out, using methods of higher precision than heretofore, and it is hoped that the cause of the apparent anomaly may be ultimately tracked down. Unfortunately it is a very laborious and discouraging business, as is any investigation in which uncontrolled factors are continually operating.

4. In vivo hemolysis. My investigations on in vivo lysis referred to in last year's report have been continued this year with the help of Mr. Chester Hyman and Mr. Lyman White. We now have complete data on the way in which lysis depends on the cell concentration and serum concentration, and the theoretical part of the work has been completed. Most of the experiments this year have been concerned with the perfusion of organs with the object of finding out the extent to which lysins, such as saponin and the bile salts, are taken up by tissues. The tissue apparently takes up the lysin at a steadily diminishing rate, the percentage of lysin removed from the system being linear with time; by extrapolating the line to zero percentage uptake and measuring the area under it, we find the "uptake capacity" of the organ for the lysin. The quantity of lysin taken up may be very great, as much as 100 milligrams of saponin and 60 milligrams of sodium taurocholate disappearing in the course of a single perfusion. Looked at from the standpoint of intravascular hemolysis being produced by lysins circulating in the blood stream, this means that such lysins would have to be present in much greater quantities than would be expected at first sight, because the quantities combining with tissue cells would reduce the quantity available for acting on the red cells themselves. Furthermore, considerable quantities of the lysins are inactivated between serum proteins, and so the general result is that only in the presence of relatively enormous quantities of lysin would appreciable intravascular hemolysis occur.

5. Fixed framework. Continuing the investigation of the amount of fixed framework in the red cell, Dr. Velick and I worked out the

quantity of fixed framework in erythrocytes produced by the injection of phenylhydrazine. (See Dr. Velick's report).

6. Photodynamic hemolysis. Dr. Davson and I carried out experiments on the permeability of red cells during photodynamic hemolysis and on the effects of temperature on the "light" and "after-light" phases, respectively. The principal conclusion is that the mechanism of the after-light hemolysis is different from that of the light hemolysis proper, and due to secondary changes, resulting from injury produced during the light phase. (See Dr. Davson's report).

7. Anti-sphering factor. Continuing last year's work, the substance which prevents the sphering of red cells between slide and coverslip has been shown to be crystalbumin. (See Mr. Furchgott's report).

8. Target area of red cell suspensions. In connection with studies on the conductivity and light-scattering of suspensions of oriented red cells (see Dr. Velick's report), the problem arose as to what is the effective area or "target area" which the cells present in the direction of the current flow or of the light. To take an extreme instance, all the cells might be oriented edge-on, or they might be oriented face-on, but in any actual case the orientation would be somewhere between the two. The first problem is to find the first mean target area and its mean square deviation, and a further problem arises because if the layer of suspension is of any considerable depth, some cells must lie in the same light path as others, producing, as it were, a series of total and partial eclipses. These two problems, the "target problem" and the "eclipse problem", are classical ones, and have never been satisfactorily solved; they are dealt with in a paper shortly to be published in the Bulletin of Mathematical Biophysics by Dr. Richard T. Cox and myself.

Dr. William H. Summerson's Report
Cornell University Medical College

1. The study of the respiratory metabolism of the copper-deficient rat was continued, using the tissue-slice method and the new differential manometer. No significant differences between the metabolism of normal tissues and of copper-deficient tissues could be detected.

2. The effect of serum on tissue respiration was studied by attempting to find a more suitable type of tissue which demonstrated such an effect than the bone marrow of Warren or the exudate leucocytes of Ponder and MacLeod. It was found that rat brain showed no differences in respiratory rate between serum and Ringer solution as media, while rat testis appeared to show such a difference, although not as striking as shown by bone marrow. Rat liver is essentially comparable to rat testis. It was concluded at this stage that bone marrow (rabbit) would be the most suitable type of tissue to use.

3. A study was begun of the metabolism of exudate leucocytes of the rabbit in Ringer-bicarbonate and in serum. The oxygen uptake of leucocytes in serum appeared to be much higher than in Ringer-bicarbonate or "neutralized serum" (serum which has been freed from most

of its bicarbonate), as reported by MacLeod and Rhoads. This work is in progress at the present time.

Dr. Sidney Velick's Report
The Johns Hopkins University

My intention in working at the Biological Laboratory was to get some basic data on reticulocytes and avian red cells that would be of possible use in the study of the physiology of the malaria parasite. The first project was the study of the size and shape and the erythrocytes of five species of birds using the hematocrit, the filiar eyepiece micrometer, and calibrated microphotographs. In all cases the calculation of individual cell volumes using the measured axes and assuming a simple ellipsoidal shape agreed with the measured cell volumes within the limits of accuracy set by the methods of measuring cell volume and cell thickness.

The comparatively close agreement of the avian erythrocyte with a simple mathematical model suggested the possibly useful application of the electrical conductivity method of determining volume concentration. This was desirable first because the hematocrit is even more unreliable for avian cells than it is for mammalian cells, and second because it would offer a good experimental check on the theory of the method since the mathematical model used for mammalian cells is not a really satisfactory approximation of the true shape of mammalian erythrocytes. The mathematical theory of the electrical conductance of suspension of non-conducting ellipsoids was therefore worked out, with the collaboration of Manuel Gorin, and experimentally verified on suspensions of duck and chicken erythrocytes.

One of the experimental difficulties in conductivity measurements of blood has always been the large changes in conductance after stirring. Since flow orientation of the cells seemed likely, the theory was extended to cover the case of orientation, and tested experimentally in a conductivity cell in which the blood flowed continuously between the electrodes. The orientation was verified by light transmission measurements (in Baltimore).

The remainder of the time was spent in the study of reticulocytes. Crystalline hemin was prepared from pig blood and converted to protoporphyrin, with which some preliminary fluorescence studies were made with the object of investigating the nature of the fluorescent substance in reticulocytes. The fixed framework of reticulocytes produced in rabbits by injection of phenylhydrazine was measured and found to be several times higher than that of normal red cells. In a series of respiration measurements using the Warburg technique a single sample of anemic blood was separated into fractions containing different amounts of reticulocytes, and the oxygen consumption was shown to be directly proportional to the number of reticulocytes in the fraction. Comparisons were also made of the respiration of reticulocytes produced by phenylhydrazine and by hemorrhage.

Finally a method of obtaining free nuclei of avian red cells was worked out and the weight of an individual nucleus determined. Conductance and electrokinetic studies of the nuclei are in progress.

Dr. Charles O. Warren's Report
Cornell University Medical College

Experiments were conducted on the metabolism of rabbit bone marrow in vitro. The particular problem under investigation was the relation of the oxygen consumption and lactic acid formation to the type of cell predominating in the marrow. Some animals were bled and the hemoglobin reinjected intraperitoneally, while others were given injections of phenylhydrazine. In both instances the marrows showed a preponderance of immature red blood cells and it was found that the metabolism had changed so that a larger proportion of the total metabolism was of the oxidative type, suggesting that the formation of red blood cells involves active oxidative processes.

Preliminary experiments were also conducted, in association with Dr. Sidney Velick, on the mechanism of the action of phenylhydrazine in increasing the oxygen consumption of red blood cells. The experiments suggested that this is a secondary effect due to the liberation from the marrow of immature red blood cells.

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