OBSERVATIONS ON THE LIVING DEVELOPING NERVE FIBER.[1]

BY

Ross G. Harrison.

The immediate object of the following experiments was to obtain a method by which the end of a growing nerve could be brought under direct observation while alive, in order that a correct conception might be had regarding what takes place as the fiber extends during embryonic development from the nerve center out to the periphery.

The method employed was to isolate pieces of embryonic tissue, known to give rise to nerve fibers, as for example, the whole or fragments of the medullary tube, or ectoderm from the branchial region, and to observe their further development. The pieces were taken from frog embryos about 3 mm. long at which stage, *i. e.*, shortly after the closure of the medullary folds, there is no visible differentiation of the nerve elements. After carefully dissecting it out, the piece of tissue is removed by a fine pipette to a cover slip upon which is a drop of lymph freshly drawn from one of the lymph-sacs of an adult frog. The lymph clots very quickly, holding the tissue in a fixed position. The cover slip is then inverted over a hollow slide and the rim sealed with paraffine. When reasonable aseptic precautions are taken, tissues will live under these conditions for a week and in some cases specimens have been kept alive for nearly four weeks. Such specimens may be readily observed from day to day under highly magnifying powers.

While the cell aggregates, which make up the different organs and organ complexes of the embryo, do not undergo normal transformation in form, owing, no doubt, in part, to the abnormal conditions of mechanical tension to which they are subjected; nevertheless, the individual tissue elements do differentiate characteristically. Groups of epidermis cells round themselves off into little spheres or stretch out into long bands, their cilia remain active for a week or more and a typical cuticular border develops. Masses of cells taken from the myotomes differentiate into muscle fibers showing fibrillæ with typical striations. When portions of myotomes are left attached to a piece of the medullary cord the muscle fibers which develop will, after two or three days, exhibit frequent contractions. In pieces of nervous tissue numerous fibers are formed, though, owing to the fact that they are developed largely within the mass

[1] Read before the Society for Experimental Biology and Medicine at the 23d meeting, New York, May 22, 1907.

of transplanted tissue itself, their mode of development cannot always be followed. However, in a large number of cases fibers were observed which left the mass of nerve tissue and extended out into the surrounding lymph-clot. It is these structures which concern us at the present time.

In the majority of cases the fibers were not observed until they had almost completed their development, having been found usually two, occasionally three, and once or twice four days after isolation of the tissue. They consist of an almost hyaline protoplasm, entirely devoid of the yolk granules, with which the cell-bodies are gorged. Within this protoplasm there is no definiteness of structure; though a faint fibrillation may sometimes be observed and faintly-defined granules are discernible. The fibers are about 1.5-3 μ thick and their contours show here and there irregular varicosities. The most remarkable feature of the fiber is its enlarged end, from which extend numerous fine simple or branched filaments. The end swelling bears a resemblance to certain rhizopods and close observation reveals a continual change in form, especially as regards the origin and branching of the filaments. In fact, the changes are so rapid that it is difficult to draw the details accurately. It is clear we have before us a mass of protoplasm undergoing amœboid movements. If we examine sections of young normal embryos shortly after the first nerves have developed, we find exactly similar structures at the end of the developing nerve fibers. This is especially so in the case of the fibers which are connected with the giant cells described by Rohon and Beard.

Still more instructive are the cases in which the fiber is brought under observation before it has completed its growth. Then it is found that the end is very active and that its movement results in the drawing out and lengthening of the fiber to which it is attached. One fiber was observed to lengthen almost 20 μ in 25 minutes, another over 25 μ in 50 minutes. The longest fibers observed were 0.2 mm. in length.

When the placodal thickenings of the branchial region are isolated, similar fibers are formed and in several of these cases they have been seen to arise from individual cells. On the other hand, other tissues of the embryo, such as myotomes, yolk endoderm, notochord, and indifferent ectoderm form the abdominal region do not give rise to structures of this kind. There can, therefore, be no doubt that we are dealing with a specific characteristic of nervous tissue.

It has not as yet been found possible to make permanent specimens which show the isolated nerve fibers completely intact. The structures are so delicate that the mere immersion in the preserving fluid is sufficient

to cause violent tearing and this very frequently results in the tearing away of the tissue in its entirety from the clot. Nevertheless, sections have been cut of some of the specimens and nerves have been traced from the walls of the medullary tube but they were in all cases broken off short.

In view of this difficulty an effort, which resulted successfully, was made to obtain permanent specimens in a somewhat different way. A piece of medullary cord about four or five segments long was excised from an embryo and this was replaced by a cylindrical clot of proper length and caliber which was obtained by allowing blood or lymph of an adult frog to clot in a capillary tube. No difficulty was experienced in healing the clot into the embryo in proper position. After two, three, or four days the specimens were preserved and examined in serial sections. It was found that the funicular fibers form the brain and anterior part of the cord, consisting of naked axones without sheath cells, had grown for a considerable distance into the clot.

These observations show beyond question that the nerve fiber develops by the outflowing of protoplasm from the central cells. This protoplasm retains its amœboid activity at its distal end, the result being that it is drawn out into a long thread which becomes the axis cylinder. No other cells or living structures take part in this process.

The development of the nerve fiber is thus brought about by means of one of the very primitive properties of living protoplasm, amœboid movement, which, though probably common to some extent to all the cells of the embryo, is especially accentuated in the nerve cells at this period of development.

The possibility becomes apparent of applying the above method to the study of the influences which act upon a growing nerve. While at present it seems certain that the mere outgrowth of the fibers is largely independent of external stimuli, it is, of course, probable that in the body of the embryo there are many influences which guide the moving end and bring about contact with the proper end structure. The method here employed may be of value in analyzing these factors.

APPOINTMENTS.

Dr. Harold D. Senior, of the Wistar Institute of Anatomy, has accepted the position of Associate Professor of Anatomy at Syracuse University and will take up the duties of his new position in September. During the past winter Dr. Senior has been filling the chair of anatomy at Washington University, St. Louis, carrying on the work of Dr. R. J. Terry, who is at Harvard University on leave of absence.

REPORTS.

CONCERNING THE WISTAR INSTITUTE OF ANATOMY.

On Monday, March 4, the Board of Managers of the Wistar Institute of Anatomy held its annual meeting to consider the work of the year just closed and to approve plans for the year 1907.

As the principal aim of the Institute is to serve the science of anatomy it may be of interest to present here a brief excerpt from the Director's report, which reviewed the essential points of the year's activities, gave a full statement of the Institute's finances and suggested plans for the future.

The general plan of the Institute, outlined early in 1905, was to organize an Advisory Board of Anatomists, which should be representative of the active research anatomists of the country, and by the assistance of such a Board to determine from time to time the details of a plan which would enable the Wistar Institute, with is modest but steadily increasing endowment, to render the greatest aid to the science of anatomy. The plan further contemplated the organization of a local scientific staff, the assembling of such laboratory equipment as would be required, not only in the ordinary research work of the Institute, but also from time to time in extraordinary researches originating here or elsewhere, and the constant addition to the museum of materials of actual scientific value.

The plan met with the approval of those anatomists who were consulted.

The Advisory Board at its first meeting prepared definite suggestions for the establishment of a local research staff and for placing the Institute in the proper relation to research anatomy.

The following committees were appointed:

On Neurology and the Establishment of Relations with the International Association of Academies: Dr H. H. Donaldson, Chairman; Dr. L. F. Barker, Dr. F. P. Mall, Dr. J. P. McMurrich, Dr. C. S. Minot.

On the relations of the Wistar Institute to American Anatomists: Prof. S. H. Gage, Chairman; Dr. G. Carl Huber, Dr. G. A. Piersol.

On Comparative Anatomy and Embryology: Dr. G. S. Huntington, Chairman; Dr. E. G. Conklin, Dr. F. P. Mall.

Aside from the routine duties in connection with a public museum almost the entire year 1905 was spent in developing the plans suggested.

At the beginning of 1906, the records of which we have just officially closed, the Institute secured as its research chief in neurology Dr. Henry H. Donaldson and the real work was begun. Later in the year the scien-

tific staff was augumented by the election of Dr. George L. Streeter and Dr. S. Hatai as Associates in Neurology, making a total of seven on the staff.

The internal readjustment of the affairs of the Institute and the equipment of the laboratories have progressed steadily during the year.

In April, 1906, the second meeting of the Advisory Board was called, and the results of their discussion are briefly set forth in the following suggestions:

1. That the Institute initiate a study of racial anatomy of the brain and cooperate with foreign institutes to secures brains of other races.

2. That the Neurological Committee be requested to consider means for the further organization of neurological workers in this country.

3. That it be recommended to develop a staff of expert laboratory assistants, such as draughtsmen, modelers. and technicians, to facilitate the mechanical work of research.

4. That investigators be admitted from time to time by the Director to the full advantages of the laboratories as guests for such periods as may be determined upon.

5. That whenever opportunity offers of obtaining specially desirable material for the study of comparative anatomy and embryology this should be secured and preserved for future use.

Of suggestion No. 1 our report will show an addition to our collection of 77 human brains, representing the racial anatomy of this organ. Nine of these specimens are worthy of special mention, but for obvious reasons their identity must be withheld. This is an important part of our work, and the large number collected during the year is due primarily to our relations with other institutions. The collection of human brains representing race types is perhaps one of our most important and immediate duties as a museum, for this will be impossible in the not very distant future.

Concerning recommendation No. 2, it may be said that the Neurological Committee has made progress. Its work is not yet completed and cannot be reported in full. An effort is being made to connect our Institute with other institutions which will furnish opportunities for clinical work and the collection of another class of material.

Recommendation No. 3 is perhaps one of the most important for the success of our laboratory and can be carried out when our income is augmented or when we are able to economize in some other direction.

To make our facilities complete and satisfactory we must have laboratory assistants, draughtsmen, modelers, and technicians as recommended.

It is just here that most laboratories are weak and are unable to furnish the investigator with that perfection of apparatus and technical assistance which will enable him to complete his researches. This part of our force will be developed as rapidly as possible. It must be said, however, that such equipment should come slowly as the work demands it, otherwise there will be a useless waste of energy and funds.

Investigators are admitted to our laboratories as proposed in recommendation No. 4. A number have availed themselves of the opportunity during the year.

Concerning recommendation No. 5 it may be said that we have collected and stored material for comparative anatomy whenever the opportunity presented itself. The museum is especially rich in certain lines and some of this material has been sent to investigators in other laboratories.

As a result of our effort to create here a Central Anatomical Institute and of our decision to follow neurology for the present as our major subject we received, in February, from the Central Commission for Brain Investigation, through the Imperial Academy of Sciences at Vienna, a formal recognition of the Wistar Institute as an international central institute for brain research in America. Hereafter all work in America in cooperation with the Central Brain Commission may be communicated through the Wistar Institute.

In May a meeting of this Commission was held in Vienna. Professor Donaldson, as a member and the Director of the Institute, by special invitation, attended this meeting. The actions of this Commission, soon to be published by Professor Waldeyer, will be of interest to neurologists.

Naturally our museum growth has been greatest in neurological material, and while not great in numbers every specimen is significant. In the museum catalogue during the year 148 entries have been made, comprising 27 series of neurological preparations containing 2568 slides; 23 series of shad embryos, 6 reconstructions of the developing shad's heart, 2 models of embryo shad (the series of embryos, reconstructions and models all belonging to one research), and 77 human brains of special value and interest, the remaining entries consist of a variety of anatomical material. Of the human brains received 63 were negro brains presented by Professor Franklin P. Mall, of Johns Hopkins University. They represent a series which has been carefully studied for certain race characteristics (American Journal of Anatomy, Vol. V, No. 4,) and are now held for future investigations on the brain of this race. Nine brains of special individual interest have been received during the year. In addition to these the museum has acquired a number of special

preparations presenting normal human anatomy, which add to the attractiveness of this part of the museum, though they are not of special research significance.

The equipment of the laboratories has required no small amount of attention. Such apparatus as may be purchased in the markets has been supplied. The best forms of Zeiss microscopes, photographic lenses, the newest types of microtomes, and the many other appliances which go to make up a laboratory equipment have been furnished.

Among the special devices which have been built in our own shop may be mentioned the projection and photomicrographic apparatus. This instrument is designed to meet the requirements of the anatomical laboratory where drawing or photographs from sections or other objects may be required and obtained with the least possible effort and minimum amount of time, or where the object may be studied directly and measurements made by means of this apparatus without the photographic processes. The apparatus is always in working order, no rearrangement of cumbersome pieces being necessary to operate it. The apparatus is mounted in a dark room, with a developing room adjoining, directly in one of our main laboratories so that the work of preserving, preparing, and photographing or drawing a specimen may be done on the same floor within a radius of a few feet.

Although we now have two large microtomes the reconstruction of a new brain-cutting microtome for much finer and better work is underway. This will add to our facilities for producing valuable series of brain sections.

As anatomy has been studied by the various mechanical means of analyses there now remains the chemical means of attack. For this purpose the Institute has recently equipped a bio-chemic laboratory supplied with all the necessary apparatus, much of which was constructed in our own shop. I mention in some detail these bits of special equipment to emphasize the fact that our shop facilities make it possible to supply any apparatus which cannot be purchased in the market but which may be demanded for special research work.

Concerning library facilities it is not necessary for me to say that Philadelphia is unequaled in this respect, the magnificent library of the Academy of Natural Sciences, of the American Philosophical Society, of the College of Physicians, and of the University of Pennsylvania, not to mention a number of other large libraries are all accessible to the members of our laboratory. Of the Institute's library it may be said that here are to be found all the principal journals and reference books required

in anatomical work. This year 46 new volumes were added to our library, making a total to date of 1486 bound volumes. We have received 41 periodicals and 14 books issued in parts, 55 in all. The reprints have all been carefully catalogued under both author and subject.

One of our most important accessions is, perhaps, a complete set of the bibliography cards relating to microscopy, physiology, and anatomy, issued by the Concilium Bibliographicum. They are divided as follows: Microscopy, 3230 cards; physiology, 16,098 cards, and anatomy, 28,056 cards, making a total of 47,384 cards correctly filed and accessible. These cards represent bibliographical data in the three subjects named from 1898 to date, excepting in physiology, in which branch the publication was discontinued from 1899 to 1904, but was resumed in 1905. This set of cards of the Concilium Bibliographicum is, I believe ,the only set in Philadelphia, and is, of course, open to anyone who may desire to use it.

While every book has been accessioned, I regret to say that on account of lack of time we have been unable to complete our card catalogue of the library. This will be taken up during the summer months when there are less demands from other directions upon the time of the librarian.

The neurological library belonging to Professor H. H. Donaldson has been placed in the Institute for the use of investigators in the laboratories. The library consists of more than 1000 bound volumes and 4000 reprints and subscribes to 14 scientific journals. It forms a most valuable acquisition to our working equipment.

In this connection I must also mention the very valuable library, consisting of some 4000 volumes, largely scientific, willed to the Institute by General Wistar and which has been placed in dust-proof cases in a specially prepared room at the Institute.

It is with pardonable pride that I record the results of our efforts to establish research in our laboratories and make our museum subservient thereto. Investigations for the present are directed to neurology, and the chief resources of the Institute are being expended to develop research in this department; there is no desire, however, or effort made to limit researches to this field, should any investigator desire to pursue in our laboratories investigations in any other field. In neurology, under the direction of Professor Donaldson, some fourteen pieces of research are underway in our own laboratory while a number of others are being prosecuted elsewhere, also under Professor Donaldson's direction.

In pursuing researches in neurology it is essential to have an abundant supply of fresh material, and a single type of animal tends to increase the accuracy of deductions. It is for this reason that we have established

a colony of Albino rats which are bred to a standard of weight and size and furnish material of the proper kind. This colony comprises several hundred animals. In addition to this we have established also a colony of opossums (*Didelphys virginiana*) the only representative of its family in America and presenting an extremely interesting anatomy from the neurological and embryological standpoint. These two forms will furnish abundant material of its kind for laboratory use.

Every effort will be made to strengthen our relations with other laboratories and to assist in every possible way in promoting researches in anatomy. To this end we have attempted to take the most liberal view in all matters relating to the privileges offered by the Institute, a policy which I believe will tend to knit together in the closest bonds the men who are so unselfishly devoting their lives to the development of our science.

A number of men have availed themselves of the laboratory privileges during the year and we are glad to say that there is always room and the necessary supplies for the man who has a problem to solve and knows how to solve it.

At their recent meeting the Board of Managers of the Institute took a number of important steps for the promotion of our work. They authorized the Director to dispose of such materials of the museum as have only taxonomic interest and secure in lieu thereof materials related more properly to the problem of the Institute; they also authorized the support of a research room at the Woods Hole Laboratory, and a subvention to the American Journal of Anatomy. The Director was also authorized to make such arrangements with the Graduate School of the University of Pennsylvania for the promotion of research work in anatomy as will be mutually beneficial, and the same arrangements and privileges are to be extended to other universities which may desire to cooperate. The details of such arrangements will be considered by the Advisory Board.

M. J. Greenman.

REVIEWS.

"PAPERS FROM THE ANATOMICAL LABORATORY OF ST. LOUIS UNIVERSITY," by A. C. Eycleshymer. Volumes I-III, 1904-6.

Since Professor Mark set the example in numbering and distributing the publications from his laboratory in a systematic form, we have become

accustomed to volumes of collected papers from other laboratories,[1] which in a true way show their activity. Professor Mark holds the first endowed chair of anatomy in America, the incumbents having contributed their full share in developing the science of anatomy and zoölogy with us. Professor Eycleshymer is at the head of the newly established anatomical department of St. Louis University, and these three volumes of studies show what will result when anatomy is placed in charge of an able specialist who is supported by a strong staff.

The Papers, comprising wholly reprints from foreign and American journals and from university publications, cover a wide range of subjects, such as embryology, neurology, topographical anatomy, anomalies, and general topics. Physicians and surgeons will be interested especially in the exhaustive study of the topography of the viscera by Potter, which is also published as a monograph by the University of Missouri. Those who doubt the practical value of scientific work in medicine are referred to Potter's excellent study.

I cannot fail to express my strong approval of a department of anatomy which renders so good an account of itself, for it is through departments like Professor Eycleshymer's that our standing as anatomists will finally be established. Medical schools that place anatomy upon a scientific foundation, as has been done by the St. Louis University, are certainly

[1] I have at hand the following list of collected papers which are arranged in chorological order:

(1) Contributions from the Zoölogical Laboratory of Harvard University, 1884-1906, 183 numbers.

(2) Studies from the Pathological Laboratory, Columbian University, 1890-1905, 10 volumes, 132 numbers.

(3) Papers from the Anatomical Laboratory, Johns Hopkins University, 1893-1906, 11 volumes, 198 numbers.

(4) Contributions from the Anatomical Laboratory of Brown University, 1898-1905, 4 volumes, 65 numbers.

(5) Contributions from the Biological Laboratory of Bryn Mawr College, 1904-1905, 5 volumes, 70 numbers.

(6) Studies from the Rockefeller Institute for Medical Research, 1902-1906, 5 volumes, 115 numbers.

(7) Papers from the Department of Anatomy, University of California, 1903-1905, 2 volumes, 24 numbers.

(8) Contributions from the Anatomical Laboratory of the University of Wisconsin, 1904-1906, Vol. 2, 32 numbers.

(9) Papers from the Anatomical Laboratory of St. Louis University, 1904-1906, 3 volumes, 19 numbers.

doing their duty to the medical profession, for students who have the good fortune to come under the broadening influence of scientists make the best physicians.

Franklin P. Mall.

"ANATOMICAL TERMINOLOGY: WITH SPECIAL REFERENCE TO THE [BNA]," by Lewellys F. Barker, M. D., Professor of Medicine, Johns Hopkins University; formerly Professor of Anatomy in Rush Medical College, University of Chicago. With vocabularies in Latin and English. Two colored and several other illustrations. Price, $1.00. P. Blakiston's Son & Co., Philadelphia, 1907.

This is the latest addition to the valuable series of books written by Professor Barker in the interests of anatomical science. The primary object of the present work is to present the origin, nature, and aims of the Basle Anatomical Nomenclature [BNA], and to promote its adoption in the English-speaking countries.

Many of the objections and difficulties that have arisen in connection with the use of the BNA are met by Professor Barker with clear and convincing arguments. One misconception in particular which has retarded the acceptance of this nomenclature is the idea that the terms of the BNA are intended to be used unmodified in everyday speech. It is pointed out that this is not the case. Even the distinguished authors of the BNA do not adhere to it strictly in their lectures. The primary purpose of the BNA is rather to serve as a standard for use in written works, especially in those intended for international use. It was expected that each nation, in spoken language, would in the case of many of the terms prefer the equivalent term in the native tongue to the Latin form. This procedure has in the present work been facilitated for English-speaking students of anatomy by placing in parallel columns the BNA and the literal English equivalents. The English equivalents are not necessarily preferable, however, even for use in speaking; and there is a tendency, which most teachers using the system have probably noticed, for the students to adopt the Latin terms as English. But the Literal English equivalents will in any event serve as convenient stepping-stones, where the Latin terms are not already familiar.

An additional help to those unfamiliar with the BNA is provided by placing in parenthesis the common English synonym, where this is not practically identical with the BNA. About 650 "old terms" are thus introduced, but the corresponding BNA are by no means all new terms.

In the majority of these cases the BNA is already familiar in English, or is so slightly different as to be readily recognized.

As a matter of fact, as is pointed out, it is really incorrect to designate the BNA as a "new nomenclature." Probably less than 5 per cent of its 5000 terms are actually new to English-speaking anatomists. And it must be conceded that the great majority of these new terms are decided improvements. The few inappropriate and undesirable terms will doubtless be corrected in future revisions of the BNA.

Two colored figures are included, representing the surface regions according to the BNA. Incidentally it may be noted that an authoritative statement of the precise boundaries of the various regions would be useful to clinicians and others interested in the surface form of the body.

In addition to anatomists this work will doubtless be of much service to zoölogists, physiologists, pathologists, and clinicians who desire to familiarize themselves with the revised anatomical nomenclature, which may now be fairly considered as well-established in this country.

C. M. Jackson.

COURSES IN ANATOMY, HISTOLOGY, AND EMBRYOLOGY AT THE UNIVERSITY OF MICHIGAN, 1906-7.

ANATOMICAL STAFF.

J. Playfair McMurrich, A. M., Ph. D., Professor of Anatomy.
Simon M. Yutzy, M. D., Demonstrator of Anatomy.
Robert Bennett Bean, B. S., M. D., Instructor in Anatomy.
Henry W. Stiles, M. D., Assistant Demonstrator.
Joseph D. Heitger, A. B., Assistant Demonstrator.
Mark Marshall, B. S., A. B., Assistant Demonstrator.
Grace D. Peele, B. S., Assistant Demonstrator.
Cyrenus G. Darling, M. D., Clinical Professor of Surgery, Lecturer in Surgical Anatomy.

I. Osteology. Laboratory work and recitations. Two hours daily, for nine weeks. Drs. McMurrich, Yutzy, Bean, and Stiles.

II. Practical Anatomy. Four hours daily for twenty-four weeks, accompanied with lectures on the morphology of the human body, twice daily. Drs. McMurrich, Yutzy, Bean, and Stiles.

III. Anatomy of the Central Nervous System. Lectures and demonstrations. Two hours weekly for eighteen weeks. Laboratory work one hour daily for three weeks. Dr. McMurrich.

IV. Anatomy of the Central Nervous System. Laboratory course. Optional. Dr. McMurrich. Hours arranged with instructor.

V. Anatomy of the Lymphatic System. Lectures ten hours. Dr. McMurrich.

VI. Topographic Anatomy of the Ear. Lectures and demonstrations, six hours. Dr. McMurrich.

VII. Topographic Anatomy of the Air Passages. Lectures and Demonstrations, six hours. Dr. Yutzy.

VIII. Topographic Anatomy of the Abdominal and Thoracic Viscera. Lectures and demonstrations, eight hours. Dr. Bean.

IX. Topographic Anatomy Studied on Sections Optional. Dr. Bean. Hours arranged with instructor.

X. Surgical Anatomy. Lectures and demonstrations, twenty-seven hours. Dr. Darling.

XI. Special Problems in Anatomy. Optional. Dr. McMurrich. Hours arranged with instructor.

XII. Practical Anatomy for Dental Students. Laboratory work, three hours daily, for nine weeks. Dr. Stiles.

HISTOLOGY AND EMBRYOLOGY.

G. Carl Huber, Professor.
Lydia M. DeWitt, B. S., M. D., Instructor.
Herbert N. F. Nichols, A. B., Technical Assistant.

I. Embryology, Histogenesis, and Histology. Lectures, recitations, and demonstrations, three hours weekly, for thirty-two weeks. Dr. Huber.

II. Laboratory Work in Histology and Histogenesis. Sections of about fifty students working four hours daily for nine weeks. (Two to three sections a year.) Drs. Huber and DeWitt.

III. Lectures, Recitations, and Laboratory Work in Histology. Arranged for dental students. Three hours daily for twelve weeks. Drs. Huber and DeWitt.

IV. Laboratory Work in Vertebrate Embryology. Optional. Dr. Huber.

V. Technical Methods in Vertebrate Histology and Embryology. Drs. Huber and DeWitt.

VI. Research Work in Vertebrate Histology and Embryology. Dr. Huber.