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GEORGE LINIUS STREETER

1873—1948

A Biographical Memoir by

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George Linius Streeter was generally recognized during the latter years of his life by the embryologists of the world as their leader in the study of human embryology. From 1914 until his death in 1948 he was connected with the Department of Embryology of the Carnegie Institution of Washington, of which he was Director for 23 years (1917–1940). So fully indeed did he plan and lead the work of the Baltimore embryological laboratory that his fame and that of his department are scarcely separable.

Dr. Streeter was born January 12, 1873 at Johnstown in western New York, whither his family, of English descent, had migrated by way of New England. His father was a leader in the chief industry of that region, glove manufacturing. After being graduated from Union College in 1895 he studied at the College of Physicians and Surgeons of Columbia University and took the degree of Doctor of Medicine in 1899. While in medical school his interest in human anatomy was aroused by Columbia's accomplished professor of that subject, George S. Huntington.

After an internship in Roosevelt Hospital, New York City, Streeter became assistant to Dr. Henry Hun, the eminent neurologist in Albany. During two years thus spent in the practice of medicine he served also as demonstrator of the anatomy of the nervous system in Albany Medical College. Intending to become a specialist in clinical neurology, he went to Germany in 1902 to prepare himself for that career by research with the great Frankfurt anatomist, Ludwig Edinger. He also studied with Wilhelm His at Leipzig and was at Berlin for a time. In retrospect it is easy to see that it was His's influence rather than that of Edinger which prevailed with him, for after publishing two papers on his investigation, under Edinger, of the adult brain and spinal cord, and a brief article on neurological technique, he devoted himself irrevocably to

embryology. The first of his Frankfurt articles is an excellent example of the kind of anatomical research into brain structure which was then in progress in many laboratories under the influence of Retzius, Edinger and other Continental neurologists. It is a careful description of the nuclei and fiber tracts in the floor of the fourth ventricle of the human brain, where the VIIth to the XIth cranial nerves originate. The other article describes the spinal cord of the ostrich, which interested Streeter because of the peculiarly large development of that part of the cord which provides innervation for the huge legs of the bird. Although these papers scarcely presage the scope of his later work, they exhibit his lucid style of exposition, his talent for drawing and his precise technique.

Finding himself to be clearly at home in research he abandoned his plans for practice and upon returning to the United States he accepted an invitation from F. P. Mall to join the young department of anatomy at Johns Hopkins Medical School. There he was a member of an extraordinarily able group. Besides Mall himself, the department included Ross G. Harrison, Charles R. Bardeen, Warren H. Lewis, and Florence R. Sabin. Each of these six young scientists was doing important research and all of them were destined to reach distinction. Streeter published in 1904 his first contribution to embryology, on the development of the cranial and spinal nerves in the occipital region of the human embryo. The material came chiefly from Mall's collection. This was descriptive morphology, based on accurate reconstruction from serial sections. For that kind of investigation, which he continued throughout his career, he was particularly fitted by his strong powers of visual construction aided by accuracy in observation and excellent draftsmanship.

During his Johns Hopkins instructorship, influenced no doubt by the example of Harrison and Lewis, Streeter made an excursion into experimental research, studying the results of removing and transplanting the ear vesicles in tadpoles. Although he did not continue, after 1909, the direct study of living embryos by operative methods, these early experiments gave him a permanent appreciation of the fact, sometimes neglected

by morphologists, that an embryo is not merely an incompleted stage in development but is itself a living creature and its component parts are not only "Anlagen" but working organs.

During the three years of his Johns Hopkins appointment he continued to put together the information he had gained from the embryological material placed at his disposal by Hertwig at Berlin, His at Leipzig, and Mall at Baltimore in the study particularly of the development of the internal ear and its nervous connections. This was the beginning of an interest in the development of the human auditory apparatus. He was still writing on this subject as late as 1931 and his researches include a full description of the embryology of the external ear, of the labyrinth and cochlea, and of the whole ganglionic apparatus and the cranial nerves associated with the organs of hearing and equilibration. The monograph of 1918 on the perilymphatic spaces of the labyrinth is a complete and sumptuously illustrated account of a subject on which very little had previously been written. It has been found invaluable by later students in clarifying the relations within the petrous bone.

For one year in 1906–1907 Streeter was engaged in research at the Wistar Institute of Anatomy and Biology in Philadelphia with the rank of Assistant Professor under H. H. Donaldson. In 1907 he was invited to the University of Michigan, where he remained for seven years as Professor in Charge of Gross Human Anatomy and Director of the Anatomical Laboratory.

The pedagogical problems of these years are reflected in Streeter's bibliography by manuals of dissection for medical and dental students, and by a couple of brief papers on embalming bodies for dissection and other technical procedures, but in spite of professorial distractions the even flow of his research continued, with further studies on the development of the ear and of the human brain and peripheral nervous system.

In 1914 his old chief at the Johns Hopkins anatomical laboratory, F. P. Mall, who had just launched the Department of Embryology of the Carnegie Institution of Washington, called him back to Baltimore as Research Associate in the new enterprise. Three years later Mall's untimely death resulted in Streeter's appointment to the directorship. He took over from

his distinguished predecessor a well-organized laboratory and a clear-cut, far-reaching plan of research on all aspects of human embryology. The department already possessed one of the world's largest collections of human embryological material. Under Streeter's guidance Mall's plan was admirably executed and in many respects expanded. The collection grew in size and quality. Talented technical aides, artists, modeler, photographer, and microtomist, were trained to meet his high standards. Not only was the morphology of the embryo studied intensively, but experimentalists like Warren Lewis, Margaret Lewis, Hartman and Metz, and the anthropometrist Schultz were given facilities and encouragement. Twenty-two volumes of the Contributions to Embryology, of the Carnegie Institution of Washington (VIII to XXIX), published during his directorship and edited by him, bear witness to the extraordinary productivity of this group under his generous, enthusiastic leadership.

Streeter's personal research for the rest of his life was to a large extent determined by the nature of his post. Mall's program, set forth in his remarkable "Plea for an Institute of Human Embryology" in the Journal of the American Medical Association, May 24, 1913 outlined a program of research on what he designated larger questions of human embryology including the curve of growth, development of the external form and internal anatomy of the embryo at successive stages, organogenesis (especially of the brain), histogenesis, the study of embryonic pathology including malformations, the comparative embryology of related species, and experimental embryology to elucidate problems of human development. Comparing Streeter's work published after 1917 with the divisions of the basic plan, it becomes evident that he contributed personally to every major topic on the list except experimental embryology. His work during these three decades can be most clearly described by topics rather than chronologically.

A certain difficulty presents itself to the biographer who attempts to point out the nature of his research, which was characterized by precision rather than by novelty. The achievement was the attainment of such perfection in the study of

material so important yet so difficult to amass and prepare. Streeter was never an explorer of the rough and ready kind. His work contains few totally novel observations, but he possessed supreme ability to take up imperfectly understood phases of embryonic development, refining, integrating, and accurately depicting them. His predilection for this kind of work was founded, no doubt, upon the mental characteristics that went with his exceptional talent for accurate drawing. An intimate associate of his mature years tells how Streeter when examining a new specimen would take pencil in hand and make a free hand sketch so correct that when the younger man afterward made a drawing for the records with the aid of a camera lucida, Streeter's sketch would closely fit the mechanically traced outline. One who draws so precisely has to see the object with perfect comprehension. It was the urge to see and understand, not merely theorize about the unknown transition stages of morphogenesis that made Streeter a great descriptive embryologist.

In fulfillment of this desire he demanded and obtained good material and did not rest until the gaps were filled. His description for example of the development of the labyrinth of the ear, and that of the major internal structures of the brain, in fact all his larger morphological contributions, are so perfectly done that they completely supersede all previous work on those subjects and defy further refinement by methods known at present. Such work is appreciated by experienced colleagues but its content of factual discovery is not readily explainable to the general reader. With these characteristics in mind we may however look with somewhat greater comprehension at the results of his labors.

Mall's first "larger question" pertained to the curve of growth of the human embryo. To answer this question Streeter and his colleagues patiently measured all the embryos and fetuses that came to the laboratory, tabulating the clinical histories, and noting particularly those cases in which the record of gestation age was especially clear by reason of favorable circumstances, e.g. history of a single relevant coitus. When a sufficient number of observations was in hand Streeter published (1920) his

paper on "Weight, sitting height, head size, foot length and menstrual age of the human embryo," accompanied by six charts. This is the classical account of human prenatal growth, to which every embryologist goes when it is necessary to ascertain the age of a fetus or late embryo from its dimensions. At the end of his life Streeter was actively engaged in collating and publishing, in his "Horizons in human development," the information necessary to determine gestation age from physical characteristics in the earlier stages of development, when ordinary dimensions of weight and linear size are not helpful.

The precision of Streeter's tables and curves, and of the pictures of embryos that he chose to accompany them, is so great that the Carnegie embryologists, reporting on clinical specimens, are confidently able to state the age of an embryo within a couple of days, or of a fetus to the exact week, from its general form and dimensions; and even if the specimen has been damaged, its age can still be ascertained with close approximation from the sitting height alone or the foot length or head measurements or from the form of head or hand.

Turning next to the program of studies in the anatomy, organogenesis and histogenesis of the human embryo, here too Streeter made notable contributions. He published admirable descriptions of two very early embryos, the "Mateer" and the "Miller," the latter of which is about 11 days old and was at the time of his paper (1926) the youngest known human embryo. The part Streeter played in encouraging the collection and description of other early human embryos will be discussed later. His study of the developing brain had reached its high point before he became director of the Carnegie Laboratory. Mall probably emphasized brain embryology in his plan because he wanted to get Streeter for his staff. Most of the latter's work on this topic is summarized in his chapter on the nervous system in the Keibel-Mall Handbook of Embryology (1912), which has not yet been superseded as the most comprehensive monograph on the development of the human brain. Streeter also went deeply into the special problem of the development of the blood vessels of the brain (1915, 1918). His other great contribution to human organogenesis, the series of papers on

the development of the internal and external auditory apparatus, has already been mentioned. The "Developmental horizons," which will be specially discussed below, include a careful study of the histogenesis of bone, a valuable review of the development of the human heart and numerous incidental observations on many phases of organ-formation.

Streeter was always interested in the embryological aspects of twinning, and although he wrote little about twin human embryos, his attention to the subject is reflected in the records of the Carnegie Collection with its histories of 300 cases of twin embryos and fetuses; in the extensive memoranda which he gathered from the literature; and in two papers, one on single-ovum twinning in the pig (1924) and the other on the formation of single-ovum twins in man. The latter is based largely on the 17-day Mateer ovum, which contains atypical vesicles then interpreted by Streeter as possibly representing a twin in arrested development, a conjecture which he afterward abandoned.

The Carnegie embryological laboratory has always been much concerned with the pathological aspects of embryonic and fetal development. Even if such problems had not demanded attention on purely scientific grounds, they would have been forced upon Streeter's attention by the duty, assumed by the laboratory, of examining aborted fetuses and malformed embryos, sent in by physicians seeking to know how to avert the loss and distress involved in these domestic tragedies. Franklin Mall and Arthur W. Meyer, who was Mall's scientific executor in this respect, had greatly improved the description and classification of the prenatally dead, retarded, or malformed human being. Streeter turned his attention to analysis of the causes of prenatal damage and to the intensive study of one particular kind of injury, namely local deficiencies resulting from disordered histogenesis. With regard to fundamental causation, the pendulum of thought swung in Streeter's mind to the opposite position from that of Mall, who in his great monograph of 1909, "Causes underlying the origin of human monsters," had emphasized the importance of defective uterine environment. Mall had been influenced by the contemporary work of experi-

mental embryologists who had succeeded in producing maldevelopment of aquatic embryos by placing toxic substances in their environment; Streeter on the other hand was influenced by the more recent work of geneticists on lethal and sublethal genes. Putting together their conclusions with his own reflections he became an exponent of the view lucidly set forth in his Harvey Society Lecture of 1934 that morbid processes in the fetus are largely due to genetic causes.

The pendulum is now swinging back to an intermediate position, in which both genetic and environmental causes are accepted, for still more recent experimental work has proved that embryonic malformation may be brought about by toxic and malnutritional factors of various sorts; but Streeter's skilled exposition was exceedingly valuable in turning the thought of physicians to the importance of genetic factors in human development.

His most significant specific contribution to prenatal pathology is the remarkable article of 1930 on focal deficiencies and their relation to intra-uterine amputation. Infants are sometimes born without a hand or foot, or with a finger missing, but with a well-formed stump like that resulting from a surgical amputation, showing that the missing limb or part had actually developed like its mate, but was subsequently obliterated and resorbed. Still more frequently, aborted fetuses exhibit such intra-uterine amputations, and in these cases there are often adhesions between the amniotic membrane and the amputation stump. In such cases the shriveled limb, not yet fully disorganized, may still be present distally to the adherent amniotic band. Sometimes, even more startlingly, the umbilical cord is found tightly looped about a limb. The latter is deeply grooved by the constricting cord, and may be necrotic beyond the point of constriction. The assumption had always been made that interference with the blood circulation by the adherent amnion, or by the looped cord, is the primary cause of damage to a previously normal part of the body. Streeter, with eyes trained by a vast experience in scrutinizing damaged fetal tissues, perceived that in these cases the amnion becomes adherent to the fetal body where the tissues are already damaged, presumably

by local growth failure due to genetic causes, much as adhesions of the peritoneum or pleura of the adult body are produced by local damage resulting from infection. He showed, furthermore, that loops of the umbilical cord are practically speaking always associated with fetuses that had died in utero before they were aborted; that is to say the looping of the cord is the result rather than the cause of the damage which leads to amputation. In his monograph this revolutionary concept is vigorously explained and demonstrated with a profusion of pictures. The paper well illustrates the basic method by which Streeter's temperament led him to work. The general question came first, namely what do fetal malformations really reveal to careful study? Then came slow painstaking assembly, recording and classification of specimens, until he had seen enough to realize the meaning of small similarities and differences between one specimen and the next. Then a relatively small, or at least closely-defined problem which had become apparent during the exploratory period was selected for intensive study. The records accumulated in years of routine work were placed side by side. Numerous sketches were made. The facts, now apparent to the trained eye, were marshalled with systematic precision. The textual description and exposition was most carefully drawn up, and graphic illustrations by artist and photographer were planned and assembled with convincing thoroughness. The adjective "meticulous," so often used, in ignorance of its etymology, to mean merely careful, correctly describes Streeter's method of work, for he actually seemed afraid to be inaccurate, obscure, or superficial. Another characteristic of his work must be emphasized. This is that the topics of his investigations often seem deceptively narrower than they really were. No one can read attentively the paper on focal deficiencies, or the little masterpiece of observation and exposition on the formation of the filum terminale of the spinal cord (1919) or many another of his works, without being led by his treatment of the specific topic, small as that might seem, toward a strong realization of the general processes of growth and differentiation.

Embryology as Streeter thus developed it was essentially

morphological, and yet was a morphology of living tissues. Taught by his brief period as a practicing physician to see the frame of man as a functioning organism; influenced by his short period of experimentation on living embryos mentioned above, and trained for a time in neurology, that branch of anatomy in which the relation of structure to function is most forcibly apparent, he always tended to visualize the processes of growth and change, even though the embryo under his microscope had long since been permanently preserved, cut into sections and cemented upon glass slides. Walter Cannon's aphorism "A microscope slide is a frozen moment in the flux of life" exactly represents this attitude. Streeter's emphasis on the fact that the detailed structures of an embryo are parts of a living, currently integrated individual, not merely items of a blue-print for the adult, or relics of its evolution, set up in his mind a strong antagonism to that kind of embryology represented in its extreme form by Haeckel's law of recapitulation, which looked at every embryonic structure as if it were merely a record of phylogeny.

His whole attitude on the question of simplification and diagramming in embryology was cleverly summed up in his presidential address "Archetypes and Symbolism" before the American Association of Anatomists in 1927. In this address, discussing the old concept that the vetebrate brain is fundamentally constructed of three vesicles, he said "the brain begins to build its definitive parts before the closure of the neural tube, without going through a preliminary archetypal indifferent three-vesicle stage. With further experience and additional material this has been abundantly substantiated in the pig as well as in man. There seems to be no evidence that the brain wastes any empty gestures toward the past. With no false moves it proceeds directly with the building of an organ appropriate in all its parts for the respective species. It has taken us a long time to find this out. It probably would not have taken so long if we had not been so well satisfied with the diagrammatic concept of three brain vesicles." Streeter over-reacted so strongly to the comparative-historical kind of embryology that he even discountenanced, for example, mention of gills in connection

with the branchial bars of the mammalian embryo. At lunch-time discussions in the laboratory he enjoyed being very positive on this and similar topics, although sometimes it appeared that his resistance to phylogenetic embryology was consciously exaggerated for the fun of argument. The positive gain from this attitude will be appreciated if one looks at the illustrations of Streeter's papers, which are completely free from the kind of diagrammatic oversimplification that has so often betrayed embryological thought, as he suggested in the address quoted above. Whenever possible he used a photograph, or had his artist make a realistic drawing. Diagrams were sparingly used and even the most schematic of them were based directly on actual sections.

One of Streeter's studies in comparative embryology was deliberately undertaken because of his critical attitude toward schematic interpretations. At the beginning of the present century some of the comparative embryologists were, as Streeter wrote, "apparently intoxicated by the simplification of the mechanics of development that seemed to be offered by the principle of metamerism," and not stopping their metamerism with the middle germ layer, they were applying it also to other tissues including the medullary tube. There was in fact a definite doctrine of segmentation of the embryonic brain. Some of the most definite claims of this sort having been based upon study of chick embryos, Streeter turned again to the chick. By photographs and dissections of a series of beautifully prepared embryos, he satisfied himself that there is no true metamerism of the brain. The various subdivisions of the developing neural tissue of the head do not reflect the evolutionary history of the region but rather the development of centers of correlation and control, related to the sense organs. He concluded this paper on the status of metamerism in the central nervous system (1933) with the characteristic remark "It is inconceivable that any rigid geometrical scheme could be as marvellous as the reality of the blending adaptation maintained between the embryonic nervous system and the body structures which it is to serve, as they exist at the moment, whereby the two are continuously and perfectly coordinated."

About 1925 Streeter and his colleague Chester H. Heuser began a collaboration that was to last for several years, in research on the early embryology of the domestic pig. The slaughterhouse then operating near the Johns Hopkins Medical School, which years before had provided much of the material for the studies of Mall's pupils, was again utilized. Newly available knowledge of the sow's ovarian cycle facilitated the detection of very early pregnancies.

The superb photography and microtomy of Heuser furnished magnificent preparations from which first Streeter (1927) and then Heuser and Streeter jointly (1929) published papers that together comprise one of the most accurate and complete descriptions of the early embryology of a mammal that has ever appeared. The 1927 paper, which deals with the middle germ layer or mesoblast, is an outstanding example of a method of study frequently necessary in mammalian embryology; that is to say, the application of information gained by experimental workers on the more accessible embryos of oviparous animals to explain what is seen in the mammal. As a competent critic, G. W. Bartelmez, has said, in this monograph Dr. Streeter "succeeded in putting life into boxes of slides."

In 1925 Carl G. Hartman, who had long cherished an ambitious plan of research on the reproductive cycle of the rhesus monkey, the most readily available of the infra-human primates, was persuaded by Streeter to join the Carnegie Department of Embryology and to collaborate with Streeter and Heuser by collecting material for the embryology as well as the physiology of reproduction in rhesus. G. W. Corner had shown, with a little colony of rhesus monkeys adjacent to the Carnegie laboratory, that this species could be maintained and handled under conditions favorable for such an effort. To Hartman's energy and persistence Heuser's masterly knowledge of very early embryos and skilled handling of the material were again added. After eight years of laborious work by all three collaborators, papers on the anatomy and rate of development of early embryos, implantation and membrane formation began to appear. At each annual meeting of the American Association of Anatomists for several years and at two international meetings,

Streeter was present to give one of his charming brief talks on one or another of these topics, illustrated by the incomparable photographs of Chester F. Reather, who had been instructed in this exacting kind of photography by Streeter and Heuser, and by the drawings of the famous Carnegie illustrator, James F. Didusch. The embryological work culminated in two monographs, one by Streeter and George B. Wislocki of Harvard University on the placentation of the rhesus monkey (1938) and the other by Streeter and Heuser on the development of the rhesus embryo (1941). It is not too much to say that this piece of research stands in the front rank of American scientific achievements, by reason of the professional skill lavished upon it under Streeter's leadership by the four investigators, the artist and photographer, by the expert modeler O. O. Heard, by A. G. Rever, who was Hartman's chief aid in breeding and operating upon the animals, and by the rest of the laboratory staff, backed by the Division of Publications of the Carnegie Institution. What embryologist, aware of the difficulties that beset the study of very early embryology even in animals as readily available as the pig, rabbit, guinea pig, and cat, would have predicted in 1925 that by 1950 two primate species (rhesus and man) would be among the best understood of all the mammals as regards their early development?

The great advance in early human embryology made during Streeter's directorship was also a piece of teamwork. Until the 1940's human development before the end of the second week was scarcely known at all. The Miller ovum, of 11 days, described (as above mentioned) in 1926 by Streeter, was the earliest stage in the textbooks. Arthur T. Hertig, who spent a year under Streeter as a Rockefeller Fellow in 1933–1934, returned to Boston and rose to a place of responsibility as pathologist to the Boston Lying-in Hospital and the Free Hospital for Women in Brookline. With the aid of a Carnegie grant he and the scholarly gynecologist John Rock undertook the systematic collection of early human embryos in the large surgical-pathological material of the Free Hospital. The discovery and handling of the individual specimens was of course greatly facilitated by what Hertig had learned from Hartman's and

Heuser's experience in the collection of monkey embryos. Each of the precious specimens was brought to Baltimore for preliminary study and sectioning by Heuser. With increasing acuity in the search, earlier and earlier stages were obtained. During Streeter's lifetime he was able to see the whole picture of human development from about the 7th day on, and to have glimpses of still earlier stages. The great success of the program is now well known to embryologists the world over, from the annual Carnegie Director's Reports and from the papers of Hertig and Rock which have thus far appeared, but the magnitude of the achievement will scarcely be appreciated until the embryos now in hand are fully described and tabulated. In this enterprise Streeter took the part of elder statesman, encouraging and advising but not himself publishing primary reports.

When in 1940 he retired from his directorship, he began at once to work on the culminating task of his career, the preparation of a descriptive catalog and classification of human embryos according to the sequence of development, in order to be able to compare one specimen with another, to judge their age, and to recognize retardations and abnormalities of development. Because embryos undergo extreme transformations of shape while growing rapidly in size, they cannot be classified by any dimensional measurement that is comparable through all the stages from the egg to the fetal period; nor are there any anatomic features that are available throughout. The somites for example do not begin to develop until day 20, and become useless for dating the later stages because the addition of new somites ceases before the end of the embryonic period. It is necessary to define the successive stages by taking account of a whole series of details; for example the appearance of pigment in the optic cup, the first sign of a limb bud, the closure of the otic vesicle, etc. Accurate descriptive norms and profuse illustrations are required. This "Normentafeln" method of classifying embryos has long been available though not intensively used. In the case of the human species accurate norms have been unavailable for lack of sufficent material. It is impossible, therefore, when reading many papers on mam-

malian and especially human embryology, to find out the precise stage of development of the embryos studied.

Streeter began his work on the "Developmental horizons in human embryos" by revising a tentative assignment of stages of human embryonic development made long ago by F. P. Mall for this purpose. He set up 23 stages or "horizons" from the one-cell egg to the end of the embryonic period, which he arbitrarily defined as ending when marrow formation is clearly discernible in the femur. This occurs at about 48 days, ovulation age. He chose to start his descriptions at Horizon XI (13 to 30 somites), leaving the earlier stages for later consideration. Working assiduously during the eight years Fate granted him, he prepared four articles covering Horizons XI to XVIII. When he was stricken by fatal illness the illustrations and notes for another section of his survey were on his drawing table. That section, covering stages XIX to XXIII, has been completed by two of his colleagues (Heuser and Corner), and work is under way on the first 10 stages. The published articles form a continuous description of the external form and major internal structures of the human embryo during the latter half of the embryonic period, with a catalog of the useful embryos of each stage in the Carnegie Collection, profusely illustrated with photographs and line drawings. Streeter selected those features which were changing most rapidly at a given time, to characterize that particular stage of development. With the aid of his photographs, diagrams and tables it is readily possible to check the relevant characteristics of an embryo and assign it to its place in the series of growth stages, much as in using a taxonomist's key in identifying species of plants or animals. The text, as mentioned above, also includes a great deal of new descriptive material, especially on the development of the heart and of bone tissue. This exceedingly instructive and useful task could have been accomplished by no one else, and only with the great collection that had been assembled under Streeter's leadership.

The story of his scientific career must also include a word about his influence upon guest investigators who came from many States of the Union and foreign countries to work with

Streeter and his colleagues. All of these visitors developed an affectionate regard for Dr. Streeter. Their numerous research reports in the Carnegie Contributions to Embryology and elsewhere are sufficient proof of his always generous and helpful leadership. Severely critical as he was, he never considered embryology an esoteric craft, and was always ready to provide ways and means for investigation by serious people.

Streeter's enthusiastic desire to communicate his knowledge to interested listeners made him a very good speaker in spite of his innate shyness. His full-length lectures were models of graceful exposition, but his immediate colleagues will perhaps most happily recall his almost annual appearances at the Anatomists' meetings, when he modestly took his twelve-minute turn, presenting each time one carefully chosen topic from his recent work, clearly stated and beautifully illustrated, clinching the single point once for all.

He had rather austere views about the matter of bringing science to the public, feeling that front-rank investigators like those of his laboratory ought to inform physicians and medical school and college teachers about the results of their research, but are not called upon to write or speak at a more popular level. His publications therefore include only a few lectures before general audiences and articles written for scientific magazines. Though excellent in style and characteristically well illustrated, these articles make no effort at superficial appeal.

Dr. Streeter considered scientific research the highest human activity. He never wished to do any other kind of work. Administration was something that had to be done to keep research going. In business affairs he was thorough and cautious. Avoiding difficulties by forethought, he seldom had to act drastically. He did not seek outside responsibilities but cheerfully accepted such as he felt were matters of duty. He was for several years Chairman of a Division of Animal Biology that was set up within the Carnegie Institution for administrative purposes. He served the National Academy of Sciences as chairman of several committees. A call to civic service in Baltimore as member and subsequently President of the Board of the Samuel Ready School, an endowed residential school for

girls, greatly touched him and he devoted himself generously to its management. His sense of form and good taste enabled him to take an active part in the planning of three fine buildings, the new wing of the Carnegie Institution administration building in Washington, with its effective Elihu Root Auditorium, the Samuel Ready School in Baltimore, and the modern home which he and Mrs. Streeter built in 1937 at 3707 St. Paul Street, Baltimore. In later years his counsel was much sought by younger colleagues, by fellow investigators, and by his successor in the directorship. He was always willing to discuss their problems, but would never let a scientific visitor go without turning again to his microscope and drawings, with gentle insistence ending the interview with an embryological discourse on whatever he was studying at the time.

It is a pity that no one ever made a "candid camera" picture of him in one of these moments of bright enthusiasm. He was shy before the camera and there is no photograph that shows his characteristic cheerfulness and alertness. His personal charm, compounded of courtesy, thoughtfulness, and a kind of happy buoyancy, won the affection of everyone who knew him well. He was reticent with strangers but an enthusiastic conversationalist with intimates. His ideas and convictions, which were conservative in matters of politics, finance and social controversy, but often venturesome in scientific matters, were seldom expressed directly. Because of his diffidence, he found it easier to hint at his own views, and to elicit those of others, by unexpected remarks and questions, fundamentally thoughtful but often humorously exaggerated, impish, or contrary. This method of discourse was sometimes surprising to new acquaintances but it was free from malice and those who could take it were always rewarded by a spirited conversation and by generous consideration of their own opinions.

Dr. Streeter's achievements and services were recognized by many honors. He was elected to the National Academy of Sciences in 1931 and to the American Philosophical Society in 1943. His professional colleagues in the American Association of Anatomists made him their President (1926-1928). In 1928 he was elected Fellow of the Royal Society of Edinburgh.

Trinity College, Dublin, in 1928 gave him the honorary degree of Doctor of Science, as did his own college, Union, in 1930. The University of Michigan, where he taught for seven years, made him LL.D. in 1935.

The always fortunate circumstances of his professional career were matched by his happy family life. While at Ann Arbor he married (1910) Julia Allen Smith of that city, a lady particularly fitted by her own talents for graphic art to understand and encourage his work. Their son and one of the two daughters have followed their father in the medical profession. The elder daughter took her doctorate in chemistry.

This lifetime of uninterrupted achievement, so calm in its outward aspects, so full of the inner excitement that comes from scientific discovery, came to a quiet end on July 27, 1948, when Dr. Streeter, on vacation in his Adirondack summer cottage, was stricken without warning by a heart attack. On the last day of his life his microscope and his drawing board were at hand, and he was still studying the marvelous processes of human embryonic development.

KEY TO ABBREVIATIONS USED IN BIBLIOGRAPHY

Albany Med. Ann.=Albany Medical Annals
Amer. Jour. Anat.=American Journal of Anatomy
Amer. Jour. Obstet. Gynecol.=American Journal of Obstetrics and Gynecology
Anat. Anz.=Anatomischer Anzeiger
Anat. Rec.=Anatomical Record
Arch. f. mikr. Anat.=Archiv für mikroskopische Anatomie
Ber. des Inst. Internat. d'Embryol.=Berichte des Institute International d'Embryologie
Brit. Med. Jour.=British Medical Journal
Bull. Johns Hopkins Hosp.=Bulletin of Johns Hopkins Hospital
Carnegie Inst. Wash. News Serv. Bull.=Carnegie Institution of Washington News Service Bulletin
Carnegie Inst. Wash. Year Book=Carnegie Institution of Washington Year Book
Contrib. Embryol.=Contributions to Embryology
Jour. Amer. Med. Assn.=Journal of the American Medical Association
Jour. Comp. Neurol.=Journal of Comparative Neurology
Jour. Exper. Zool.=Journal of Experimental Zoology
Phys. Surg.=Physician and Surgeon
Proc. Inst. Med. Chicago=Proceedings, Institute of Medicine of Chicago
Proc. Nat. Acad. Sci.=Proceedings, National Academy of Sciences
Proc. Soc. Res. Child Develop. Nat. Res. Coun.=Proceedings, Society for Research in Child Development, National Research Council
Sci. Mo.=Scientific Monthly
Trans. Amer. Otol. Soc.=Transactions, American Otological Society
Trans. Stud. Coll. Phys. Phila.=Transactions and Studies, College of Physicians of Philadelphia
Verhandl. d. anat. Gesellsch.=Verhandlungen der anatomischen Gesellschaft

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