NATIONAL ACADEMY OF SCIENCES

ANTON JULIUS CARLSON

1875—1956

A Biographical Memoir by

LESTER R. DRAGSTEDT

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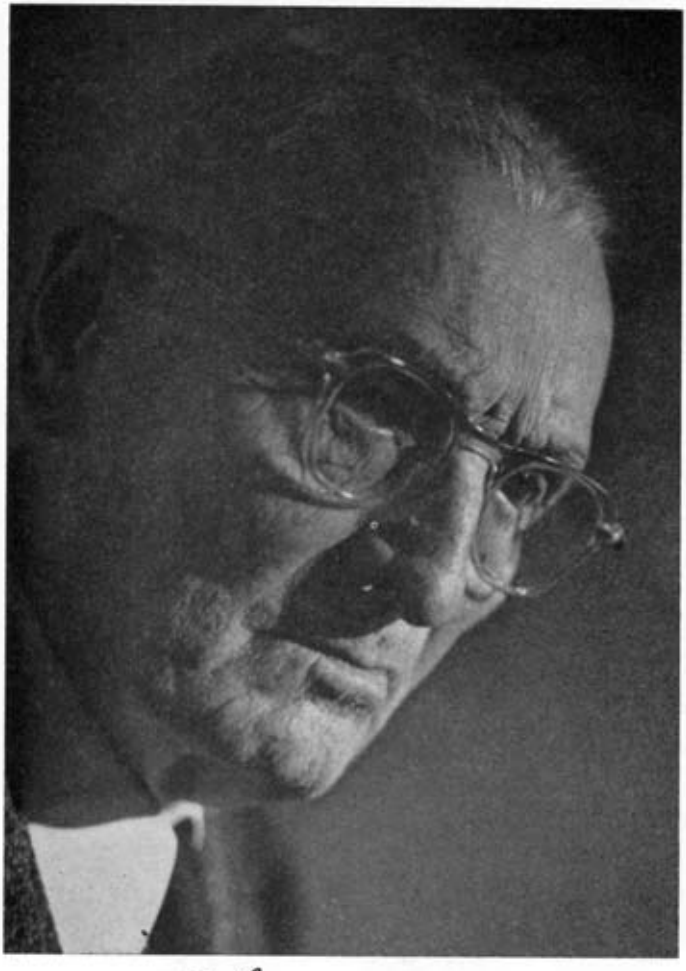

A. J. Carlson

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January 29, 1875–September 2, 1956

BY LESTER R. DRAGSTEDT

IN THE DEATH of Dr. Carlson the world has lost a vigorous voice for human freedom, science has lost a biologist of great critical judgment and intuition, and the United States a great citizen. He frequently spoke of himself as an American by choice rather than through the accident of birth. He was always grateful to America and to the University of Chicago because they gave him an opportunity to work at something that he thought was worthwhile. Biological science was the field of his main endeavor, and here he displayed the qualities of a resourceful, imaginative, and indefatigable investigator. His greatest contribution, however, was as a teacher, as an interpreter of the spirit and methods of science to the general public, and as a staunch defender of animal experimentation as an essential method for medical and biological progress. The biological insight that Carlson acquired from his years of investigation of fundamental questions in physiology enabled him to discuss clinical problems with great authority and effect. His gift for keen analysis, his ready wit and pungent criticism, so often displayed at scientific meetings, gave him an acknowledged place of leadership in biological and medical societies. It is probable that no man in America not engaged in clinical practice had so great an effect on medicine.

Anton Julius Carlson was born January 29, 1875, in the province of Bohuslan, Sweden, about half way between Gothenburg and Oslo. This is a region of small mountains covered with pine forests and

valleys, where the rocky soil reluctantly yields a meager living to the frugal and industrious farmers. The farms in these valleys, usually from ten to twenty-five acres, are exceedingly well kept and the buildings in careful repair. Carlson was born on such a small farm along with two brothers and three sisters. His father's name was Carl Jacobson. Anton's name became Carlson as was customary in the countryside of Sweden at that time. His mother's name was Hedvig Andersdotter, indicating that she was the daughter of Anders. The boy had no recollection of his grandparents and believed that they were all dead before he was born. All of his ancestors were hard-working farmer people in that region of Sweden, and no one among them was noteworthy for any special achievement. When Anton was two years old the family moved from the region of Svarteborg to a neighboring region called Puvella, close to the North Sea. Payments were made on a small farm, and conditions of life seemed somewhat brighter when tragedy struck in the death of the father and sole support of the family. He apparently developed pneumonia, and in a delirium insisted on going out in the stormy night to feed his stock. A giant of a man, the wife and children could do nothing to stop him, and the resultant exposure hastened his death. The farm was lost, and the mother was faced with the desperate task of providing food and shelter for the six children. The older sisters found work as hired girls in the homes of more prosperous neighbors; the boys found work of varying kinds on the farms. When Anton was seven years old he began working for a living, herding sheep during the summer months for neighboring farmers. For the most part during the winters he stayed at home with his mother and trudged through the snow to the small country schoolhouse two miles away. In later life Carlson always thought of his mother with love and gratitude as his best teacher. From her he learned to read and write and to value work for its own sake. She told the little boy that he who does not work shall not eat. This emphasis on work well done, so necessary for survival, was also the theme of a manual training teacher in the country school whom

Carlson always recalled with affection and respect. He told the growing boy that the finished product reveals the kind of man who made it. During the winter evenings young Anton learned to knit his own wool stockings and help his mother with all sorts of housework. Sundays were given over to the strict observance of the services of the Swedish Lutheran Church. Here there was no compromise with sin, and the stern virtues of honesty and piety were preached to the farmers and their families, who had to sit on wooden benches in the cold stone church after having trudged several miles over the snowy fields. The minister was the most educated and, consequently, the most important man in the community. He occupied a position of respect and influence approximating that of a university professor in modern times.

When Anton was sixteen years old he began to look about him and to take stock of himself and his prospects for the future. During the summers while herding sheep in the hills, he had become curious about the sea shells and fossils that he found so far from the ocean and about the large rocks ground and polished by the glaciers of the distant past. He asked his mother and his teachers who polished these stones and who carried those sea shells up into the mountains and why did they do it. They could not answer him, but they did not laugh at him because of his questions. His mother told him that if he could get an education he would know all these things. It was apparent, however, that this would be difficult if he were to remain a farmer boy in this province by the North Sea. In the meantime word had come of the wonders of America. Some of the farmers had relatives who had settled in Minnesota and Wisconsin. Anton's older brother, Albin, had become a sailor and made up his mind to seek his fortune in America. He came to Chicago, found employment with a carpenter-contractor in Englewood on Chicago's south side, married and rented a small house. A letter to Anton promised him a job with the same carpenter and enclosed sufficient money to pay for his trip to Chicago. The mother must have said goodby to this second son with heartaches and misgivings. She was never to

see him again. She did not urge him not to go, however, and wished him success in the New World.

With the money Albin had provided, Anton bought passage in Gothenburg, sailed by steamer to Hull, England, thence to New York, and by rail to Chicago. He could speak no English and must have been greatly relieved when Albin met him at the station and took him to his home in Englewood. The next day he began working as a carpenter's helper at $1.25 a day for ten hours' work. He lived with his brother Albin and worked in Englewood from March, 1891, until January, 1893. By this time he had learned a little of the English language and had saved $300.00. He had joined the Englewood Lutheran Church and become well-acquainted with the young minister. This man recognized Carlson's ability and desire for more education and suggested that he go to the Augustana Academy and College in Rock Island, Illinois. Augustana was a Swedish Lutheran college, and the Academy would make it possible for Carlson to take the preparatory work necessary to enter the college. An intensely serious and ambitious student, Carlson completed the required work in much less than the usual time and secured his Bachelor of Arts degree in 1898 and a Master of Arts degree in Philosophy in 1899. Influenced no doubt by the religious teaching of his mother and the advice of the Swedish Lutheran minister in Englewood, Carlson at first planned to enter the Lutheran ministry. However, during his college days he became increasingly skeptical of the dogmas of the Lutheran Church and was greatly disturbed. He talked over these problems with a young high school girl, Esther Sjogren, whose beauty he admired and who entertained him with occasional concerts on the piano. During his senior year in college Carlson had rented a room from her mother who had a large house not far from the college buildings. In one of his classes where the question of the efficacy of prayer for rain was being discussed, Carlson ventured the suggestion that this problem need not remain undecided any longer. He pointed out that the United States Weather Bureau had accurate records of the amount of rainfall in the various middle western states

for a great number of years. It would be a simple matter to call upon the congregations in certain areas to pray for rain and then determine by the results if the average rainfall had been altered. This suggestion was received with consternation, and although Carlson had been elected by his classmates as valedictorian, this selection was countermanded by the faculty because of their uncertainty concerning his religious attitude. He was much influenced by the professor of geology, Dr. Udden, and took part with him in one of his scientific investigations. This teacher also stimulated his inquiring mind by giving him a book, *Pre-Adamites,* to read.

Carlson was in this troubled state of mind when he finished his work at Augustana and accepted a call to go to Anaconda, Montana, as a substitute minister in the Swedish Lutheran Church of that city. While in Anaconda, Carlson stayed in the home of my grandparents and became well-acquainted with my uncle, Charles Dragstedt, a young man of about his same age. The two became good friends and spent much time roaming the mountains when not otherwise occupied. Carlson gave his sermons in the Swedish language and, in addition, taught classes in science and philosophy to the young people of the congregation. After about a year of this work he made up his mind that the only part of philosophy and psychology that he could "get his teeth in" was the physiology of the nervous system. He decided to become a physiologist. His young friend, Charles Dragstedt, helped him in this undertaking by lending him some money so that he could go to Stanford University. Here he worked with Jenkins and Greene in physiology and came under the inspiring influence of the president, David Star Jordon. He paid no attention to contemporary student life but actually lived and worked in the laboratory. He secured a Ph.D. degree in physiology in 1902.

The problem assigned to Carlson by his teacher, Dr. O. P. Jenkins, concerned the rate of conduction in the motor nerves of invertebrates. The development of the problem was left to Carlson, and here his scientific ingenuity was first displayed. He compared the

response of the pseudopod of the slug when in a markedly elongated state with the response when the pseudopod was reduced. Since the response was delayed in the elongated state, Carlson concluded that the conductive substance in the nerve fiber must be liquid in nature rather than solid.

After securing his degree Dr. Carlson was made a research associate at the Carnegie Institution and held this appointment during the years 1903 and 1904. He became interested in the heart and set for himself a solution to the question as to whether the inhibitory or the accelerator nerves to the heart appear first in evolution. He decided to investigate this problem on the lower marine animals rather than to study the embryos of higher forms of life. This work made him familiar with the comparative physiology of the heart in most of the animals available on the Pacific coast. In the summer of 1904 he went to the Marine Biological Station at Woods Hole, and it was here that he became acquainted with the unique anatomical arrangement of the heart in the Limulus or horseshoe crab. There was at this time an active controversy with respect to what was called the neurogenic and myogenic theories of conduction of the cardiac impulse. Carlson observed that in the Limulus the cardiac nerves were grouped as a ganglion extending along the surface of the heart where it could readily be divided with scissors. When this was done the transmission of the cardiac impulse from one part of the heart to the other was interrupted, and Carlson accordingly concluded that the coordination and conduction of the heartbeat in this animal was by way of the cardiac nerves. This paper created a profound impression, and when Carlson presented it to Dr. Porter, editor and owner of the American Journal of Physiology, Porter told him that he thought Carlson was wrong in both his observations and in his interpretation but that, nevertheless, he would publish his paper. As a result Carlson became immediately widely known, and his experiment was discussed in physiological laboratories all over the world. His self-confidence in presenting the results of his experimental researches impressed his hearers, and in 1904 Dr. George Neal Stewart,

professor of physiology at the University of Chicago, offered him a position as associate in the department at a salary of $1,200 per year. This was a step up the ladder, and Carlson remained at the University of Chicago for the rest of his life serving as assistant professor and later as professor and chairman of the department of physiology until he retired in 1940 as the John P. Hixon Distinguished Service Professor of Physiology Emeritus.

Carlson continued his interest in the Limulus heart, and the year after his initial publication he discovered that the heart begins to beat in the embryo of the Limulus before nerve fibers appear. This prompted him to the wondering conclusion that in this animal the heartbeat is originally myogenic in origin and conduction and that, subsequently, with the development of a nervous system in the heart the nerves take over this function.

For several years Carlson was relatively free of teaching duties and had ample time for his research. Dr. Stewart gave the lectures in physiology to the medical students and Carlson supervised the laboratory courses. Dr. A. P. Matthews and Dr. Waldermar Koch taught biochemistry and Dr. S. A. Matthews pharmacology. At this time these three subjects were combined in one department and housed in one general laboratory. This building had been constructed by Jacques Loeb, the first professor of physiology, and was designed more for studies on plant and animal tropisms than for the type of mammalian experimentation that Carlson embarked upon.

He had not been long in Chicago when he began to receive attractive offers from other universities, among them Wisconsin and McGill, and from the Mayo Clinic. It was, however, the magnetism and tremendous enthusiasm of William Rainey Harper, the first president of the University of Chicago, that kept Carlson at his post. He was also profoundly impressed by the great scientists that Harper had assembled and was happy to be associated with them. Whitman in zoology, John M. Coulter in botany, Michaelson in physics, T. C. Chamberlin in geology, and R. R. Bensley in anatomy became his friends and respected colleagues. He became acquainted with Ludvig

Hektoen, professor of pathology in Rush Medical College, somewhat later and was profoundly impressed by his great ability and interest in research. He took part in a joint investigation with Hektoen on the physiology of the thyroid gland, and it may well have been Hektoen's influence that directed Carlson's attention to clinical problems.

Beginning in about 1908 Carlson shifted his attention from the heart to the endocrine glands and became particularly interested in the thyroid and pancreas. Fatal tetany, occasionally seen after operations on the thyroid gland in man, had been recently demonstrated to be caused by accidental removal of the adjacent parathyroid glands. During his student days at Stanford, Carlson had observed that dogs from which the thyroid gland had been removed usually died in convulsions and were not benefited by thyroid feeding. He and his students investigated the nature of parathyroid tetany and observed the depression in gastro-intestinal motility and secretion present in this state. This transmitted interest in parathyroid physiology undoubtedly influenced the subsequent discovery by Luckhardt and L. R. Dragstedt of methods by means of which the lives of parathyroidectomized animals could be preserved and tetany prevented. Carlson's experiment on the pancreas has often been cited. He and his student Drennan removed the pancreas from pregnant bitches and in one of these animals observed that sugar did not appear in the urine until after the pups were born. Carlson inferred that in the intervening period the internal secretion of the pancreas of the pups had secured access to the maternal circulation and prevented diabetes in the mother until parturition. Undoubtedly this experiment stimulated subsequent research on the pancreas, and it is of interest that Scott, one of Carlson's pupils, made extracts of the pancreas by a method similar to that later found effective in the production of insulin and concluded that these extracts were beneficial in the treatment of the diabetes of depancreatized dogs. In reviewing this experiment Carlson cautioned his pupil that he had not ruled out the possibility that peptones or the non-specific effect of intra-

venous protein could account for the results secured. Possibly in this case Carlson's skepticism and his critical demand for better evidence discouraged the student and delayed the discovery of insulin for a decade.

When Professor Stewart left the University of Chicago to go to Western Reserve University, Dr. Carlson, although only an associate professor, was given complete responsibility for the Division of Physiology, which at that time was combined with biochemistry and pharmacology under the chairmanship of Professor A. P. Matthews. Dr. A. Woelfel, a graduate of Leipzig University, joined the department. Although an excellent investigator, Woelfel was a poor teacher, and as a result, Carlson and Arno B. Luckhardt gave all the lectures and supervised the laboratory work of the medical students as well as an increasing number of graduate students in physiology. Dr. Luckhardt took his doctorate in physiology with Dr. Carlson and then completed the work leading to the M.D. degree at Rush Medical College. His familiarity with clinical medicine was a great asset in the teaching of medical students and contributed much to his effectiveness in this area throughout his productive life. Although Carlson's early research was accomplished exclusively with invertebrate animals, and he had no clinical training in medicine or surgery, nevertheless, he developed at Chicago, courses in physiology involving extensive experimentation on dogs and other mammals, of great value to students of medicine. Carlson always kept the needs of the medical student foremost in his mind. In this effort the advice and assistance of Dr. Luckhardt were invaluable. Medical students in groups of four performed most of the classical experiments of physiology on anesthetized dogs that had been secured from the city pound. Each student became familiar with the anatomy of the dog and the techniques for studying the blood pressure and cardiovascular reflexes for its control. The ducts to the salivary glands and the pancreas were cannulated and experiments performed illustrating the mechanism of secretion in these glands. Similar experiments were performed to study the physiology of lymph formation and

secretion of urine. Lesions in the nervous system were produced by graduate students, and the animals made available to the medical students for diagnostic study. The physiology of the endocrine glands was usually demonstrated by graduate students serving as assistants in the medical courses.

Carlson's abiding interest in clinical medicine was manifested by his regular attendance at the meetings of the Institute of Medicine in Chicago, the Society of Internal Medicine, and occasionally, the meetings of the Chicago Pathological Society and the Chicago Surgical Society. He was frequently called upon to discuss scientific and clinical papers presented before these societies. Although not medically trained, Carlson had a biological insight that enabled him to penetrate almost instantly to the heart of the problem and to put his finger on a weak spot in the work or presentation of the speaker. His forthright, vigorous criticism did much to improve the quality of the programs in the Chicago area during his lifetime. Indeed, quite early in his career his unique ability in this respect was recognized, and if he did not arise to discuss the paper recently presented, the chairman was almost certain to call on him. It was Carlson's unvarying practice to listen to each paper with the utmost attention, particularly having in mind the nature of the evidence presented. It was his insistence on adequate proof and his oft-repeated question, "What is the evidence?" that later became his trademark throughout the scientific world.

With the outbreak of World War I, Carlson became intensely aroused. He felt that the Germans were greatly at fault and immediately made efforts to enter the military service. He was advised that he could be more helpful in the medical department of the Army, and, consequently, enlisted as a captain in the newly organized Sanitary Corps. He left the responsibilities of the department of physiology to Dr. Luckhardt, who carried them almost singlehandedly throughout the war years. After a preliminary period in Washington, Carlson was sent to England and then to France as an inspector of the quality and kind of food supplied in the army camps. At the

close of the war he was transferred to the commission headed by Herbert Hoover, and for the subsequent twelve months worked with that great humanitarian in feeding the starving children of the defeated countries. In this work Carlson visited the towns and villages of Austria, Hungary, Rumania, Albania, Montenegro, Greece, Lithuania, Latvia, Estonia, and Finland. While in Greece he climbed Mount Olympus and marveled that the ancient Greeks had not climbed that small hill to see for themselves the gods and goddesses who were supposed to live there. While in these war-devastated countries Carlson was continuously infested with body lice and was greatly concerned since typhus fever was universally endemic in those countries. His service was recognized by decorations presented to him personally by Queen Marie of Rumania and by officials in some of the other countries. He was greatly depressed by what he called the frightful "backwash" of war and the suffering endured by innocent and defenseless women and children. He was also appalled to find that the Christians in the Balkan countries were reluctant to let him supply food to certain families because they were Mohammedans and accordingly should be left to starve. When he returned to Chicago, he gave many lectures on the horror and futility of war and voiced his conviction that there were just as many "Junkers" in the allied armies as in those of the central powers. Carlson's vigorous personality impressed his colleagues and associates in the military service just as it did those in civilian life, and he was promoted to major and finally left the army as a lieutenant colonel.

When he returned to Chicago in 1919, he was utterly disillusioned as well as angered by the evidence of deceit and guile in military and civilian leaders in all the countries taking part in the great war. In an attempt to forget this bitter experience he plunged into research work in the laboratory with an intensity that was almost fantastic. He and Dr. Luckhardt initiated a series of experimental studies on the visceral sensory nervous system that kept them at work from seven o'clock in the morning until twelve, one, two, or three o'clock the next morning. After a few hours' sleep they were back in the

laboratory, experimenting and writing their reports. Carlson was annoyed by the need to leave the experiment for an hour to give a lecture to medical students. Visitors had to make their wants known in the laboratory while the experiments were in progress. Almost nothing was permitted to interrupt the work. After some six months of this frantic effort, Dr. Luckhardt called a halt saying that research was well and good but that they owed something to their wives and children. No experiments must be done on Sunday.

Following the discovery of insulin, Carlson returned to the question of the peripheral genesis of the sensation of hunger which had interested him so greatly fifteen years before. He was impressed by clinical reports that hunger was a prominent symptom of an overdose of insulin. In experiments on dogs Carlson and his pupil Bulataeo demonstrated that insulin hypoglycemia produced vigorous contractions in the empty stomach similar to those occurring during periods of starvation. These contractions did not occur if the vagus nerves to the stomach had been divided, indicating that the site of stimulation by the hypoglycemia is central. Subsequently it was found that insulin hypoglycemia also stimulates the secretion of gastric juice, but only if the vagus nerves are intact. This discovery provided an important practical test for the completeness of vagotomy when this operation is performed in the treatment of duodenal ulcer.

Although Carlson stimulated and directed the experimental research of a large number of graduate students during the next twenty years, his own activity in the laboratory largely ceased with the work on the visceral sensory nervous system. He took an increasing interest in public health, both on a local and national basis. He devoted time and effort in helping to secure free lunches for poor children in Chicago's public schools. This interest in children also prompted him to take an active part in the National Foundation for Infantile Paralysis, and he was very pleased that he lived to see the development of an effective means for the prevention of this disease. He was disturbed by the possibility that lead arsenate used by farmers and fruit growers might lead to chronic lead poisoning in large numbers

of people, partly through ingestion of insufficiently washed fruit or through contamination of the soil as a result of the use of this insecticide for many years. He cooperated with the federal government in several trials arising from this problem. He took an active part in the controversy between the producers of butter and the manufacturers of margarine. In many of these disputes he was an effective referee. He also served on the Committee for Child Health and Maternal Welfare.

The trained intuition or biological insight that made for his success as a medical investigator also enabled Dr. Carlson to survey with clear eyes the social and political problems of the day. Whenever and wherever human freedom was threatened by legislative action or prejudice, Carlson was always in the forefront as the courageous, clear-thinking, vigorous speaking champion of those whose rights were threatened. When Mussolini invited the International Physiological Society to meet in Rome, Dr. Carlson alone objected. He called attention to the Fascist law which required that all university professors in Italy must swear an oath of personal allegiance to Mussolini. He prophesied that rivers of blood would be shed before the Italian people regained their liberty. This passion for individual freedom found expression also in his work as president of the Association of University Professors and as a member of the American Civil Liberties Union. When he perceived that medical research was hampered and in many places checked by the antivivisection movement, he founded and organized the National Society for Medical Research to protect medical and biological research against this form of fanaticism.

In 1946 the American Medical Association voted him its highest honor, the Distinguished Service Award. He was a member of the National Academy of Sciences (elected in 1920), the American Philosophical Society, and served as president of the American Association for the Advancement of Science, the American Physiological Society, the Institute of Medicine of Chicago, as well as a number of other organizations. Medical men and biological scientists all over

the United States have acknowledged their great indebtedness to his dynamic teaching, his integrity, and his colorful personality. These qualities attracted to him a large number of able students who in turn became teachers in other medical schools. The profound influence of a great teacher is nowhere better illustrated than in the life and career of Dr. Carlson. Throughout his life he championed the scientific method of controlled observation and experimentation and urged its extension into other fields. He insisted that no adequate judgment could be made except on the basis of all the facts and always asked for the evidence. He was impatient with those who called for a moratorium on scientific research because this had made possible the development of terrible weapons of destruction. He was confident that a better understanding of man and nature through the conscientious employment of the methods of science would lead to a wiser control of man himself. In his closing years he devoted much thought to the social responsibilities of scientists and urged that these receive more serious attention. The American Humanist Association elected him Humanist of the Year in recognition of these efforts.

The softer side of Dr. Carlson's nature was best displayed at the summer colony, of which he was a founder member, on Elk Lake near Rapid City, Michigan. Here he cast off the burdens of the day and relaxed in the company of his family and friends. He enjoyed fishing, and his solitary figure in a duck boat silhouetted against the evening sky forms a picture that his friends will long remember. He loved to gather around the campfire with his children and sing old Swedish songs. His wife, Esther Sjogren Carlson, is his sweetheart of college days at Augustana. Much of what he accomplished in life was made possible by her work at his side, caring for the home and the education of the children. The older son, Robert, is in business in California, and the younger, Alvin, is a surgeon in Dayton, Ohio. The daughter, Alice, is the wife of Professor Hough of the University of Illinois.

Scientist, philosopher, teacher, and humanist, A. J. Carlson made

a great contribution to his adopted country, his university, his fellow scientists, and to the medical profession. However, the man was greater than any of his achievements; his personality was in itself his greatest achievement.

KEY TO ABBREVIATIONS

Am. J. Anat.=American Journal of Anatomy
Am. J. Obst.=American Journal of Obstetrics and Diseases of Women and Children
Am. J. Physiol.=American Journal of Physiology
Am. J. Pub. Health=American Journal of Public Health
Arch. Otolaryngol.=Archives of Otolaryngology
Arch. f. d. ges. Physiol.=Pflueger's Archiv für die gesamte Physiologie des Menschen und der Tiere
Arch. Int. Med.=Archives of Internal Medicine
Arch. Physical Therapy=Archives of Physical Therapy
Biol. Bull.=Biological Bulletin
Bull. Am. Acad. Tuberc. Physicians=Bulletin of the American Academy of Tuberculosis Physicians
California & West. Med.=California and Western Medicine
Compt. rend., Soc. de biol.=Comptes rendus, Société de biologie
Ergebn. d. Physiol.=Ergebnisse der Physiologie
Federation Proc.=Federation Proceedings
Illinois M. J.=Illinois Medical Journal
Interstate M. J.=Interstate Medical Journal
J. A. Am. M. Coll.=Journal of the Association of American Medical Colleges
J. Am. Chem. Soc.=Journal of the American Chemical Society
J. Am. Dietet. A.=Journal of the American Dietetic Association
J. Am. M. Ass.=Journal of the American Medical Association
J. Biol. Chem.=Journal of Biological Chemistry
J. Comp. Neurol.=Journal of Comparative Neurology
J. Comp. Neurol. and Psychol.=Journal of Comparative Neurology and Psychology
J. Exper. Zool.=Journal of Experimental Zoology
J. Gen. Physiol.=Journal of General Physiology
J. Infect. Dis.=Journal of Infectious Diseases
J. Iowa M. Soc.=Journal of the Iowa Medical Society
J. Metabol. Research=Journal of Metabolic Research
J. Missouri Med. Ass.=Journal of the Missouri Medical Association
J. Neurophysiol.=Journal of Neurophysiology
J. Nutrition=Journal of Nutrition
J. Pharm. & Exper. Therap.=Journal of Pharmacology and Experimental Therapeutics
Minnesota Med.=Minnesota Medicine
N. Y. M. J.=New York Medical Journal
Northwest Med.=Northwest Medicine
Papers and Disc. Ann. Cong. M. Educ.=Papers and Discussion, Annual Congress on Medical Education

Physiol. Rev.=Physiological Reviews
Postgrad. Med.=Postgraduate Medicine
Proc. Am. Physiol. Soc.=Proceedings of the American Physiological Society
Proc. Am. Soc. Biol. Chem.=Proceedings of the American Society of Biological Chemists
Proc. Ann. Cong. M. Educ.=Proceedings of Annual Congress on Medical Education
Proc. Inst. Med.=Proceedings of Institute of Medicine of Chicago
Proc. Soc. Exper. Biol. and Med.=Proceedings of Society for Experimental Biology and Medicine
Quart. Bull. Northwestern Univ. M. School=Quarterly Bulletin of the Northwestern University Medical School
Quart. J. Stud. on Alcohol=Quarterly Journal of Studies on Alcohol
Resenha clin-cient.=Resenha clinico-cientifica
Scient. Monthly=Scientific Monthly
Surg., Gynec. & Obst.=Surgery, Gynecology and Obstetrics
Texas Rep. Biol. & Med.=Texas Reports on Biology and Medicine
Tr. Am. Gynec. Soc.=Transactions of the American Gynecological Society
Tr. Am. Otol. Soc.=Transactions of the American Otological Society
Tr. Chicago Path. Soc.=Transactions of the Chicago Pathological Society
Tr. Chicago Soc. Int. Med.=Transactions of the Chicago Society of Internal Medicine
Univ. Penn. M. Bull.=University of Pennsylvania Medical Bulletin
Washington Univ. M. Alumni Quart.=Washington University Medical Alumni Quarterly
West. J. Surg.=Western Journal of Surgery
Ztschr. f. allg. Physiol.=Zeitschrift für allgemeine Physiologie

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