NATIONAL ACADEMY OF SCIENCES

THOMAS MILTON RIVERS

1888—1962

A Biographical Memoir by

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Biographical Memoir

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WASHINGTON D.C.

Thomas M. Rivers

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September 3, 1888–May 12, 1962

BY FRANK L. HORSFALL, JR.

THOMAS MILTON RIVERS was born on September 3, 1888, in Jonesboro, Georgia, a town some twenty miles from Atlanta and now a suburb of that city. His mother and father, Mary Martha Coleman and Alonzo Burrill Rivers, who were both born in Georgia, married and settled in Jonesboro. Alonzo Rivers, at the time of his marriage, resigned his position as a telegrapher for the Central of Georgia Railroad in order to stay in Jonesboro and became a warehouse employee. Within a few years he was manager and owner first of the warehouse, then of a large cotton gin, and next of a farm which he purchased from his wife's family; simultaneously he was buyer for a cottonseed oil manufacturer and salesman for a fertilizer company.

Rivers grew up on the family farm, which was just inside the town limits of Jonesboro and within walking distance of the local school, Middle Georgia Military Academy, at which he received his secondary school education. He had an older brother who died at the age of twelve and he himself was seriously ill at that same age with typhoid fever but survived both the disease and the heroic treatment, popular then, of starvation and ice-water baths.

All of his early school years were spent in Jonesboro. His

father provided for private tutoring by a local gentlewoman to supplement any possible deficiencies in the school curriculum. By the time Rivers was sixteen, "it didn't seem there was much more education to be had in Jonesboro," as he later recalled, and he applied for admission to Emory College, then located in Oxford, Georgia, which accepted him as a subfreshman. He received a Bachelor of Arts degree from Emory in 1909, *summa cum laude*, first in his class and with the highest four-year average recorded at Emory to that date.

Dr. Frederick N. Duncan, Professor of Biology at Emory, lived in the same boardinghouse during the years at Emory. Largely through Duncan's friendship and encouragement, Rivers came to be interested in the sciences and took as many courses in chemistry and biology as he could during his junior and senior years.[1]

Alonzo Rivers' health had begun to fail and he had hoped that his son would return home to Jonesboro to assist in his numerous business affairs. Nevertheless, he gave his consent to Tom's proposal that he enter medical school, and young Rivers entered the Johns Hopkins in the fall following his graduation from Emory.

Physically, Rivers was extraordinarily powerful although not large. While at Emory, he had taught two gymnasium classes a week in addition to his academic activities and he entered Hopkins preceded by the legend that he could lift a bale of cotton singlehanded. During his second year at medical school, however, he noted that his left hand was losing muscle tissue, growing progressively smaller and weaker. The professors of neurology and medicine at the Johns Hopkins examined

[1] The writer of this memoir is happy to acknowledge the kindness of Dr. Saul Benison of Brandeis University who made available the voluminous transcript of an as yet unpublished autobiography which was dictated by Dr. Rivers and is entitled "Tom Rivers: Reflections on a Life in Medicine and Science."

him and made a diagnosis of progressive muscular atrophy of the Aran-Duchenne type. He was told that the disease characteristically ran a rapid and fatal course and was advised to abandon his medical studies and return to his home.

He did go back to the farm in Jonesboro but, as he put it later, "I got kind of fed up waiting to die," and wrote to a friend, Dr. Claude Wynne, who was in charge of the laboratories of San Thomas Hospital in Panama. With a recommendation from "Popsie" Welch, Professor of Pathology at the Johns Hopkins, Rivers was accepted as a laboratory assistant at San Thomas. He began his medical activities in Panama by counting blood cells, performing urinalyses, staining pathology specimens, assisting at autopsies, pulling teeth, operating the X-ray machine, and carrying out sundry other delegated duties. In three months, when he had learned to speak Spanish, he was given charge of the dispensary. Shortly thereafter, in addition to his laboratory and dispensary duties, he was given responsibilities in the operating room, first administering anesthesia, then assisting at operations, and finally he was put in charge of the prison and police wards. In this last capacity he performed some eighty-five major operations and treated a great variety of infectious diseases. After eighteen months of this extraordinary activity, his own disease appeared not to have progressed and, with an appetite effectively whetted for clinical medicine, he returned to Baltimore to resume his formal medical education.

Rivers graduated in medicine from the Johns Hopkins in 1915. He was again at the top of his class, a distinction he later attributed to his lack of interest in research, which left him time to concentrate on his studies. On graduating he decided upon a career in pediatrics, although it was not a well-recognized specialty at that time. He was attracted to the treatment of children because, as he put it, "Adults have a way of lying to

their doctors. . . . Children, on the other hand, have a way of always telling the truth." He applied to John Howland for a first-year internship in pediatrics at the Hopkins but, on Howland's advice, took the coveted internship in medicine under Janeway for his first year of postdoctoral training.

During his internship he collaborated on his first clinical papers, one on a case of bichloride poisoning, which was published in the *Johns Hopkins Hospital Bulletin,* and a second, published in the *Journal of the American Medical Association,* on the transfusion of blood by the citrate method. The use of sodium citrate to prevent the clotting of blood during transfusions had been initiated in 1915 by Richard Lewinsohn of the Mt. Sinai Hospital, and the group at Hopkins, of which Rivers was the junior member, was among the first to employ the technique.

Following his year under Janeway, Rivers became assistant resident in pediatrics at the Harriet Lane Home under Howland. He showed great aptitude and enthusiasm for pediatrics and also a prodigious memory, which was always to be one of his most striking attributes. During rounds, Howland frequently called upon him to recite from memory case histories and diagnoses of patients selected at random from the hundred or more children on the wards, which, to the astonishment of the participants, Rivers was able to do.

Early in 1918 he finally succeeded in joining the Army despite his muscular atrophy and a childhood mastoid operation which had left him lacking one eardrum. He was commissioned a first lieutenant in the United States Army Medical Corps and was appointed a member of a newly formed commission to investigate an outbreak of pneumonia following measles at Fort Sam Houston. The commission was a distinguished one, headed by Rufus Cole, and included Oswald Avery, Alphonse Dochez, and Francis Blake, of the Rockefeller Institute, and William

G. MacCallum and William C. Van Glahn from the Johns Hopkins. The commission lacked only a pediatrician, and Rivers was appointed on the recommendation of Howland as "a young pup who would know measles."

After three months at Fort Sam Houston, Rivers was transferred to a commission to study empyema at Camp Lee, Virginia. Empyema at that time was treated by prompt surgical intervention. His duties were to help determine the precise location of the abscess for the surgeons, a group which included Evarts Graham. As a result of the high mortality rate observed by the commission, the postponement of operations for empyema was advocated, a procedure that was later generally and effectively adopted.

In July 1918 Rivers left the empyema commission to join the Permanent Pneumonia Board under Eugene Opie, and soon found himself in the midst of the influenza epidemic, which occupied him for the remainder of his year in the Army. From these extensive experiences came the book *Epidemic Respiratory Disease* by Opie, Blake, Small, and Rivers, published in 1921.

Rivers left the Army early in 1919. His father had died during the war and, because of his responsibilities to his mother, he was determined to push ahead with his career. He returned to the Johns Hopkins but asked Howland to release him from his pediatric training so he could pursue his newly acquired interest in medical research. With Howland's help and encouragement he secured a post in the Department of Bacteriology under MacCallum. Shortly after, he also took a position as pathologist at St. Joseph's Hospital in Baltimore in order to supplement his small income.

Rivers' first independent research involved the effects of blood on the growth of influenza bacilli and later the typing and establishment of growth requirements for various strains.

It was at this time that he and Stanhope Bayne-Jones developed their long-continuing friendship. In the course of these studies he discovered *Hemophilus parainfluenzae,* the first of his many important research contributions. This work was cut short by a fire that destroyed the laboratory in which he worked, including his biological materials and his records.

In 1922 Rufus Cole visited Baltimore and asked Rivers if he was interested in coming to the Hospital of the Rockefeller Institute to develop a laboratory for the study of viral diseases of man. Rivers paid a brief visit to the Institute, and a few weeks later Simon Flexner went to Baltimore and made Rivers a formal offer to become an Associate at the Institute and to assume charge of the infectious disease ward and also take responsibility for conducting research on viral diseases, a combination of clinical investigation and basic research that seemed ideal to Rivers, who accepted promptly.

With these bright prospects for the future, he and Theresa Riefele were married in Baltimore on August 5, 1922. After a short trip they left for New York and made their home in Forest Hills, where they continued to live for the next forty years. They had no children.

The laboratories of the Rockefeller Institute had been opened soon after its establishment in 1901, but the Hospital of the Institute, although its existence had been planned from the beginning, was not opened until 1910. Simon Flexner had originally conceived of the Hospital as a testing ground for ideas that were germinated in the laboratories. Under the insistence of Rufus Cole, however, the Hospital had its own laboratories in which the staff physicians were encouraged to initiate and carry out basic research related to their clinical studies, a policy which not only shaped Rivers' career but helped to formulate the eventual course of much clinical research in the medical schools of the United States.

Among Rivers' distinguished colleagues at the Institute were Harold Amoss, Christopher Andrewes, Oswald Avery, Wade Hampton Brown, Alfred Cohn, Louis Kunkel, Rebecca Lancefield, Karl Landsteiner, John Northrop, Peter Olitsky, Louise Pearce, Florence Sabin, Richard Shope, Wendell Stanley, Homer Swift, Peyton Rous, Donald Van Slyke, and Leslie Webster. All these and many others who joined the staff of the Institute contributed to his growth and development as a scientist.

When Rivers first began his career, virology was not an established discipline and most of the techniques, procedures, and criteria now commonly accepted in this field had yet to be developed. An investigator interested in viruses at that time needed also to be an expert clinician and pathologist, since viruses could be detected and distinguished only by their effects on the intact host, rather than by the numerous biological, chemical, and physical criteria that are now available. Rivers' early training and investigative experiences and his passion for clinical medicine made him extraordinarily well suited to the position of pre-eminence in virology that he soon achieved.

From his earliest days at the Rockefeller Institute, he worked tirelessly. He rose early every morning, seven days a week, and caught the streetcar along Queens Boulevard to the 59th Street bridge, which he crossed on foot. He was usually the first to arrive at his laboratory and the last to go, rarely leaving before 10 P.M.

The first viral disease he chose to study was varicella, partly because of the ease with which its clinical symptoms could be recognized. He soon embarked on attempts to transmit the agent to experimental animals. In 1923, he and his colleague, William Tillett, reported the probable recovery of varicella virus in rabbits. Soon after, they discovered that they were actually dealing with a latent virus of the rabbit, the infectivity of

which had been enhanced by repeated passages through this animal. This agent, which was designated Virus III, was one of the first latent viruses to be recognized and, as such, helped to establish the concept of latency, now recognized as fundamental to the understanding of several viral infections. Virus III was found to have some oncolytic activity but complete tumor destruction was not achieved.

Other phenomena that interested Rivers during this period, although he was not the first to observe them, were the production of passive local immunity, as evidenced by local regression of rashes or skin lesions following the injection of antisera, and the tendency of infectious agents to localize in areas preconditioned by other lesions such as those resulting from burn scars, local irritations, X rays, or ultraviolet light.

In 1926 he was asked by the Society of American Bacteriologists to organize a symposium on viruses for the annual Christmas week meeting. He invited the speakers, and also himself presented a paper in which he reviewed most of what was then known about viruses, including the diseases they induce, the pathological changes they produce, their size, filterability, infectivity, and immunology. In the course of this paper he stated: "Viruses appear to be obligate parasites in the sense that their reproduction is dependent on living cells." This was probably one of the most important single statements ever made in the history of virology, and one that Rivers was called upon to defend often in the course of the next decade. His position in this regard was diametrically opposed to that of many other workers in the field, including several senior members of the Rockefeller Institute, among whom was Flexner himself, who, with Noguchi, had recently claimed to have isolated polio virus and cultivated it in a lifeless medium. Rivers' stubborn insistence on this fundamental point of difference between viruses and bacteria did much to establish virology as a

separate discipline and to foster the development of knowledge about the nature of viruses and viral infections.

Early in 1928, on the basis of work done largely in his own laboratory, Rivers published a paper in the *American Journal of Pathology,* entitled "Some General Aspects of Pathological Conditions Caused by Filterable Viruses," which presented clearly for the first time a description of the major pathologic effects of viral infection, i.e., cell necrosis and cell proliferation. Later that same year, the book *Filterable Viruses* appeared. This now classic text, which had the 1926 symposium as its point of departure, was a compendium of what was then known about viral infections. This text demonstrated for the first time one of Rivers' greatest gifts, his uncanny ability to evaluate seemingly conflicting evidence and to winnow out the meaningful and durable from the irrelevant.

In 1929 and again in 1930 there were serious outbreaks of psittacosis in California and New York. The death rate was high, and a number of laboratories, including those of the Public Health Service in Washington, D.C., the New York City Department of Health, and that of Rivers at the Rockefeller Institute, undertook to study the disease. In 1930 some sixteen persons in the environs of the Washington laboratory and several workers in New York contracted parrot fever. Soon after, all other laboratories in the United States except that of Rivers stopped work on the disease. For two years his remained the only laboratory in the country that ventured to deal with psittacosis and the only one available for diagnosing the disease in man or birds. In the course of this work he greatly advanced knowledge about the diagnosis, characteristics, and spread of this highly infectious disease.

In the early 1930s Rivers, like many others, became concerned with the increasing reports of postvaccinial encephalitis occurring especially in Europe but also in the United States.

In an effort to develop a vaccinia virus strain free of contaminants, he cultivated the virus in tissue culture and developed an attenuated strain that did not leave a vaccination scar and that appeared to be uncontaminated. After clinical trials in children, however, he regretfully decided that his vaccine did not afford sufficient protection, as judged by later challenge with the conventional vaccinia virus. Although this work did not produce practical clinical results, it laid a foundation for the later development of yellow fever vaccine by Max Theiler and his colleagues.

Many investigators believed that postvaccinial encephalitis was due to a viral contaminant of the vaccine, but Rivers, always a careful pathologist, noted that these encephalitides were demyelinating in nature, unlike those produced by encephalitis viruses. In an attempt to reproduce this form of pathology in the laboratory, he injected suspensions of rabbit brain into monkeys and, in time, was able to demonstrate an experimental demyelinating encephalitis. Subsequently, he showed that similar results could be achieved by the injection of rabbit brain suspensions into the homologous host. Rivers personally considered this one of his most important scientific contributions although his name is not generally associated with studies of allergic encephalitis or with the broader problem of the autoimmune diseases.

During this period, his laboratory was the source of a great variety of productive research. Rivers and his associates were the first to demonstrate that fowl pox is transmitted by mosquitoes. They made the first definitive studies on the nature of inclusion bodies in virus-infected cells and clearly established that viral infection may proceed from a single viral particle. Rivers developed a psittacosis vaccine, using himself as an experimental subject, and did the first clinical studies on several viral infections, including louping ill, Rift Valley fever, and

lymphocytic choriomeningitis. Further, in the daily course of his work and through his widening influence on others in the field, he helped to establish standards for viral research and for the control of infection and contagion in both the laboratory and the hospital ward.

Rivers was made a Member of the Rockefeller Institute in 1927, and when Rufus Cole retired as Director of the Hospital in 1937, Rivers was appointed his successor. His unquestioning devotion and intense loyalty to the Rockefeller Institute, and especially to the Hospital, were characteristic of him and continued unabated throughout his life. Simon Flexner had retired as Director of the Institute in 1935, and Herbert Gasser had become his successor. Although they were widely dissimilar in background, training, and interests, Gasser and Rivers worked together in complete harmony and with deep mutual respect for eighteen years. Rivers undertook his new responsibilities in the Hospital with the same vigor and zeal with which he had once determined to become "the best damned pediatrician in Georgia." The welfare of every patient in "my Hospital" became his personal concern and he dogged the footsteps of nurses and resident physicians to make sure that "my patients" received the best possible medical care and most scrupulous attention. All those who worked in the Hospital during his sixteen years as Director avow with rueful admiration that he "ran a tight ship."

After he assumed directorship of the Hospital, less of his time came to be spent on research and correspondingly more on his role as administrator, arbitrator, educator, prime mover, and exhorter of investigators at the Rockefeller Institute and of American virologists in general. By the middle 1930s the Institute was undoubtedly the major center of viral research in this country and possibly the world, and served as the training and proving ground for a whole generation of

virologists, some of whom stayed on at the Institute but many of whom eventually undertook other posts throughout the United States and in other countries. Rivers remained at the pivotal center of this group throughout his lifetime. According to his philosophy, "The way you get research done is to find the guy that wants to do it and then give him the chance to work." In his astonishing memory the professional qualifications, research work, major publications, and academic positions of virtually every virologist in the country seemed to be permanently catalogued. He was always among the first to recognize and encourage the young man who wanted to get something done and to find or, if necessary, to create for him the chance to do it.

Among the many outstanding investigators of viral and other infectious processes who came under Rivers' influence at the Rockefeller Institute and who derived stimulation from association with him as colleagues or co-workers were Paul Beeson, George Berry, Edward Curnen, René Dubos, Thomas Francis, Jr., Harold Ginsberg, George Hirst, Charles Hoagland, Colin MacLeod, Maclyn McCarty, George Mirick, Ralph Muckenfuss, Robert Parker, Francis Schwentker, Thomas Scott, Joseph Smadel, Jerome Syverton, Igor Tamm, Lewis Thomas, and William Tillett, to name but a few.

In the biographical notice which he wrote soon after Rivers' death, Richard Shope, with characteristic directness and on the basis of his many years of association with and friendship for Rivers, included this perceptive evaluation:

"Although Dr. Rivers was by nature a friendly person, he had the capacity of being irascible and pugnacious. He was a difficult and formidable person to oppose and could be stubbornly inflexible in maintaining a position. His discussion at scientific meetings of findings with which he disagreed could be on occasion so stinging that the audience, even though

realizing the correctness of Rivers' position, often had their personal sympathies entirely with Rivers' opponent. Many of those of us who have known Dr. Rivers best have felt the sting that he could so picturesquely deliver in an argument. Few of us have had the nerve openly to side with his opposition in one of these 'knock-down'-and-'drag-out' discussions. It is my feeling that Dr. Rivers believed that verbal chastisement of the sort that he occasionally delivered was good for the younger virologists among us."[2]

In 1936, following the ill-fated trials of the Brodie-Parks and Kolmer polio vaccines, Rivers was asked to join the Advisory Board of the President's Birthday Ball Commission. In 1938, when the National Foundation for Infantile Paralysis was organized, he accepted a volunteer post on the Foundation's Committee on Research and was elected chairman, a post he held for seventeen years. In this capacity he played an important part in shaping the course of viral research in this country. Also, since the National Foundation was one of the first agencies of its kind in the field of medical research, he and the Committee helped to establish policies and procedures for its research grants. With his participation and encouragement, the National Foundation was among the first private agencies to guarantee support for research programs for more than one year, thus making it possible to plan ahead, attract good talent, and ensure tenure and continuity. Subsequently he was named Chairman of the Foundation's Vaccine Advisory Committee, a position he held in 1954 when the Committee assumed responsibility for the mass clinical trial of the polio virus vaccine developed by Jonas Salk.

Rivers was also active in the health affairs of New York City and served as a member of the New York City Board of

[2] *Journal of Bacteriology*, 84: 385-88, 1962.

Health for eighteen years. In 1941 he played a major role in the organization of the Public Health Research Institute of the City of New York. This became the first such institute to be supported by the public funds of a city and in large measure stands as a continuing tribute to his vigor, insistence, and foresight. He served for many years on the Research Council of the Institute and was active in the selection of its staff and the encouragement and support of its program. In 1947 he played an important role in the organization of the mass smallpox vaccination program in New York City.

He met the challenges of World War II with characteristic imagination and vigorous action. In 1939 he foresaw the entry of the United States into the war and, mindful of the considerable disruption of Rockefeller Institute activities by World War I, he began to plan to ensure continuation of the clinical and laboratory research programs. Early in 1940 he encouraged some of the members of the staff of the Hospital and the laboratories of the Institute to join the Naval Reserve, and soon after he organized the Rockefeller Hospital Naval Research Unit. Subsequently he began negotiations with the Navy to enter upon a contractual arrangement with the Rockefeller Hospital to care for Navy patients with certain diseases, including infectious hepatitis, primary atypical pneumonia, and rheumatic fever. As a result of this unusual arrangement, the Hospital was able to pursue a very active and useful, although somewhat different, program of treatment evaluation and research throughout the war years.

In July 1943 Rivers was called to Washington by the Surgeon General of the Navy, Ross McIntire, to discuss the problem of infectious diseases that plagued the armed forces in the Pacific. This meeting led to the formation of Naval Medical Research Unit 2, which was ultimately based in the South Pacific. Rivers assumed command and assembled an

extraordinary collection of scientific and medical talent. In 1944 an advance group of the Unit successfully introduced the aerial spraying of DDT to control malaria, first during the invasion of Peleliu and then, some months later, at Okinawa. Other advance units studied vectors of malaria and scrub typhus in New Guinea and the Philippines. On arrival in Guam, NAMRU 2 was confronted by an epidemic of fomite-born hookworm infection among infants—the only such epidemic ever described—which had been fostered by the damp and unsanitary living conditions forced upon the natives by the Japanese occupation. Following the Okinawa campaign, the Unit established that "Okinawa fever" was not scrub typhus, as commonly thought, but actually paratyphoid A or typhoid, contracted despite vaccination because of the overwhelming exposure, a discovery that made it possible to bring the epidemic rapidly under control. NAMRU 2 produced some 140 scientific papers during the brief but highly active period of its existence. Rivers was awarded the Legion of Merit for his achievements and eventually received promotion to Rear Admiral (ret.) in the Naval Medical Corps Reserve.

Upon his return from the South Pacific, Rivers embarked immediately upon two major undertakings. The first was the reconstruction and modernization of the Rockefeller Hospital building, with the addition of a large new wing. Although construction schedules were tightly maintained, they were not permitted to interrupt clinical or laboratory investigations for a single day. When the renovation was finally completed in 1952, the Hospital was a model of modern clinical research facilities, including many important features for the protection and isolation of patients with infectious diseases, controls at which Rivers had long been a master.

His second postwar undertaking was his comprehensive textbook, *Viral and Rickettsial Infections of Man*. The first

edition in 1948 proved so popular and the field was changing so rapidly that he found it necessary to bring out a much-expanded second edition in 1952, and an entirely rewritten third edition in 1959. These volumes serve as a monument both to his scientific stature and ability and to the devotion and energy that he always brought to any work he undertook.

In 1953, on the retirement of Herbert Gasser as Director, Detlev Bronk became President of the Rockefeller Institute and Rivers was appointed Vice-President and Director. He retired from these positions in 1955 and then promptly accepted a post with the National Foundation as Medical Director. This position he held until 1958 when he became Vice-President for Medical Affairs, a position which he retained until the time of his death.

He was elected a member of the National Academy of Sciences in 1934 and remained active until he died. He also was a member of the American Philosophical Society, Association of American Physicians, American Society for Clinical Investigation, American Association of Immunologists, Society of American Bacteriologists, Harvey Society, American Public Health Association, American Pediatric Society, American Society for Experimental Pathology, American Association of Pathologists and Bacteriologists, New York Clinical Society, and the Practitioners' Society. He served as president of the American Society for Clinical Investigation (1932), American Association of Immunologists (1934), Society of American Bacteriologists (1936), and Third International Congress for Microbiology (1939). Honorary degrees were conferred upon him by Emory University in 1936, the University of Rochester in 1938, the University of Chicago in 1941, and the Rockefeller Institute in 1961.

Dr. Rivers died on May 12, 1962, at the age of seventy-three as a result of cancer of the lung. He left three chief

legacies. The first is recorded in his scientific publications, of which there are almost 200, spanning nearly half a century and embracing much of the history and development of virology. The second is embodied in a score or more of institutions and organizations, many of which he helped to establish, in which he served so selflessly and with such devotion throughout his professional life. The third, the least tangible but perhaps the richest, is to be found in his students and disciples now serving all over the world who not only learned from his example but continue to take heart from his courage and derived determination from his invincible will to get things done.

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KEY TO ABBREVIATIONS

Abstr. Bacteriol. = Abstracts of Bacteriology
Am. Assoc. Advan. Sci. = American Association for the Advancement of Science
Am. J. Med. Sci. = American Journal of the Medical Sciences
Am. J. Pathol. = American Journal of Pathology
Am. J. Public Health = American Journal of Public Health
Ann. Internal Med. = Annals of Internal Medicine
Arch. Neurol. Psychiat. = Archives of Neurology and Psychiatry
Arch. Pathol. = Archives of Pathology
Bull. Johns Hopkins Hosp. = Bulletin of the Johns Hopkins Hospital
Bull. N.Y. Acad. Med. = Bulletin of the New York Academy of Medicine
Compt. Rend. Soc. Biol. = Comptes Rendus Hebdomadaires des Séances et Mémoires de la Société de Biologie et de Ses Filiales
Internat. Congr. Microbiol. = International Congress for Microbiology
J. Am. Med. Assoc. = Journal of the American Medical Association
J. Bacteriol. = Journal of Bacteriology
J. Chronic Diseases = Journal of Chronic Diseases
J. Exp. Med. = Journal of Experimental Medicine
J. Med. = Cincinnati Journal of Medicine
J. Med. Assoc. State Alabama = Journal of the Medical Association of the State of Alabama
J. Nat. Med. Assoc. = Journal of the National Medical Association
New England J. Med. = New England Journal of Medicine
Northwest Med. = Northwest Medicine
Penn. Med. J. = Pennsylvania Medical Journal
Physiol. Rev. = Physiological Reviews
Proc. Am. Phil. Soc. = Proceedings of the American Philosophical Society
Proc. Assoc. Res. Nervous Mental Disease = Proceedings of the Association for Research in Nervous and Mental Disease
Proc. Inter-State Postgrad. Med. Ass. North Am. = Proceedings of

the Inter-State Postgraduate Medical Assembly of North America

Proc. Soc. Exp. Biol. Med. = Proceedings of the Society for Experimental Biology and Medicine

Trans. Am. Clin. Climatol. Assoc. = Transactions of the American Clinical and Climatological Association

Trans. Am. Pediat. Soc. = Transactions of the American Pediatric Society

Trans. Assoc. Am. Physicians = Transactions of the Association of American Physicians

Trans. Coll. Physicians = Transactions and Studies of the College of Physicians of Philadelphia

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