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EUGENE FLOYD DUBOIS

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A Biographical Memoir by

JOSEPH C. AUB

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IN HIS AUTOBIOGRAPHY Eugene F. DuBois describes his happy early life at West New Brighton, Staten Island, New York, where his close-knit family lived until 1908 when they moved to New York City. In those days Staten Island remained a rural neighborhood. His childhood was spent in a comfortable, luxurious house in sparsely populated country, though even in those days they were within commuting distance of the city. Here his early training was "the best part of his education." The house was full of good books; "the atmosphere was happy and stimulating. There were no quarrels, no scoldings, no cross words." A local day school, the Staten Island Academy, occupied him from the ages of nine to fifteen. It took him about an hour to get to the school. It did not offer any good scientific training, but, even so, he became interested in collecting and preserving biological specimens. His last two years of preparatory school were spent at Milton Academy in Milton, Massachusetts, and from here, like most of his classmates, he progressed to Harvard University.

When he was sixteen years old, he and his brother spent their summer vacation volunteering as orderlies in the Army Hospital at Camp Wyckoff, at Montauk Point, Long Island. Here he nursed the very sick typhoid, malaria, and dysentery cases who were brought back in a pathetic state from our Cuban War expeditions. Throughout this period he remained well. This work left him with a "thorough and lifetime respect for the importance of nursing." No formal training could stimulate interest in clinical medicine more effectively, and his dedication to medicine resulted.

Indeed much of his subsequent scientific interest in the metabolic effects of fever, chills, and infections probably developed in this impressionable boy during this close clinical contact with severe disease. This abiding interest is obvious in the recurring studies from his laboratory on the metabolic mechanisms which produce chills, on the physiologic mechanisms which permit the body to store and lose heat and so produce increasing fever or its defervescence, on the effects of food, and on the metabolic manifestations of digestion in health and disease. His later European training increased his competence for this work, but the original stimulus which focused this lifelong attention must have come from his early experience.

At Harvard he received an A.B. degree in three years, without "distinguishing himself," but he did get "the desire to educate myself," and graduated cum laude. He started his medical career at Columbia College of Physicians and Surgeons in 1902, when "classes were large, standards low, instruction was didactic, with little bedside teaching." They learned much from private quiz classes, but these too were didactic. Ward visits, visiting sick patients, careful work on the hospital wards—such teaching had not been organized. Textbooks were based on statistical chances of diagnosis rather than the modern physiologic analysis of disease manifestations. The modern approach to teaching was still a dream—a dream to be realized ten years later. Surely he must have learned more of the art of medicine from his experience as an orderly for the very sick Spanish War veterans. After graduation in 1906, DuBois had six months before he was to start his internship. These months he spent in Berlin studying pathology under Friedrich Henke.

In the early years of this century the part-time professors of academic clinical medicine began to appreciate the great need for new fundamental knowledge. Trained investigators were rare, opportunities were rapidly expanding. There developed a group of full-time younger men in clinical medicine who were to be dedicated to investigation. These young men largely acquired their training in European departments of physiology and biochemistry, and this knowledge they could readily apply to the problems of illness. There were, however, not a sufficient number of these men going into the medical field as opposed to those entering biological sciences. This lack was the more keenly felt because of the rapid increase in the number of first-class medical schools during the early years of this century. Men trained like DuBois were much sought after as teachers of medicine.

The pressure of the teaching load on scientifically trained pioneers made many of them compromise, deserting the laboratory for a more didactic manner of teaching. DuBois was one of the few who withstood this temptation; he remained throughout his life dedicated to the scientific and laboratory approach to clinical medicine. This dedication won for him many ardent collaborators and resulted in some great contributions to present-day medicine.

After two years of internship at the Presbyterian Hospital in New York City he went abroad for further study. Study abroad was the accepted formula if one aimed for a distinguished future in medicine. For this European "finishing course," DuBois planned to study bacteriology in France, but three days before sailing, he met John Howland for about five minutes. Howland advised him to study the new field of human metabolism in Berlin. And so in 1909 he gravitated to Berlin where he met Borden Veeder (a graduate of Pennsylvania Medical School) who was also looking for research work in metabolism. Together they went to work with Magnus Levy, who was a Privatdocent at that time. But work in this laboratory proved incompatible, so they transferred to Kraus' laboratory in the Charite Hospital and worked under Theodor Brugsch.

They resurrected an old Pettenkofer-Voit metabolism machine which they put in order. They flipped a coin—DuBois lost and as a result became the subject on whom the observations were made. DuBois' and Veeder's first paper came from this collaboration on total energy requirements in diabetes (1911). This problem was related to that of Friedrich von Müller, who was also studying metabolic activity by determining the amount of nitrogen excreted in the urine. Graham Lusk, a young Professor of Physiology at Cornell, a friend of von Müller's, visited Kraus' laboratory and met DuBois and Veeder. Lusk was beginning his study of energy requirements in dogs and saw the exciting possibility of studying this also in man. The young men wrote a "confused" paper on diabetes which, on the advice of Dr. Theodore C. Janeway, Lusk later recalculated and practically rewrote; but Lusk liked the work.

This meeting of Lusk and DuBois grew into a lifelong association of great mutual devotion. DuBois said of this visit of Lusk's and the chance meeting with John Howland in New York that his "career was rough hewn by these two chance meetings."

In 1911, after having spent two years in Berlin, DuBois returned from Europe to enter the Pathology Department at the Presbyterian Hospital. The spirit of the department had changed wonderfully, yet they were naturally unable to visualize establishing metabolic research in a metabolic ward.

Meanwhile, DuBois and Veeder were both offered jobs by Lusk at Cornell. DuBois accepted, but Veeder returned to Philadelphia to the Department of Pathology with Alan Smith, and later gravitated to the rejuvenated School of Medicine at Washington University in St. Louis, where he became one of the really eminent pediatricians of his day.

As a result of all this training, DuBois was one of the first Americans who was well prepared to study metabolism and nutrition in man. Lusk had a similar interest and was able to develop DuBois' interest as no one else could have done. He was President of the Russell Sage Institute of Pathology. He obtained money from the Institute for the building of the Russell Sage Institute respiration calorimeter for humans; DuBois was in charge of it. The calorimeter was placed in a small metabolic ward in Bellevue Hospital, close to Lusk's department at Cornell. They were fortunate in that they had a skillful mechanic associated with them, G. F. Soderstrom, who spent his active life keeping this machine in excellent condition. DuBois was the Medical Director, and he soon developed a most satisfactory instrument which calibrated direct heat given off by a subject with the calculated heat derived from the respiration of oxygen absorbed and carbon dioxide exhaled. The observations determined that these two methods of calorimetry gave analogous answers and so made unnecessary the cumbersome direct determinations of actual heat loss from the body. Even though this machine was large and difficult to run, DuBois somehow avoided becoming its slave.

DuBois was fortunate in the association of a cousin, Delafield DuBois, who had considerable mathematical acumen and engineering knowledge. The two men devised a very clever technique for determining the surface area of humans. The actual determination of the surface area was obtained by covering the whole body with soft paper, cutting it up, flattening it, and making a photographic print of these pieces on paper of constant weight. The body area could thus be obtained by cutting out the unexposed paper and weighing it. Thus, knowing the surface area, a simple formula was derived to calculate this area from the known height and weight of the subject. This handsome work allowed comparative study of metabolic rates among different individuals and various diseases. It is now universally agreed that the rate of metabolism is dependent upon the surface area of the body and varies drastically only with activity or in disease. This formula was essential to the whole DuBois contribution to medicine. It allowed the establishment of normal basal metabolic rates related to surface area, which have been universally confirmed and employed.

When he started his work at Cornell, he found Philip Shaffer and Warren Coleman at Bellevue Hospital studying the metabolic requirements of typhoid fever patients as indicated through the urine. Lusk saw the possibility of extending calorimetry to the study of such a disease, and, of course, this appealed to DuBois as a better approach to mechanisms of fever. DuBois worked early on the physical mechanisms of fever and showed that the variations in total metabolism, which he observed, followed van't Hoff's law: an elevation of 3°C. in temperature would raise the metabolic rate 30 to 60 per cent. This was a problem which fascinated him and he returned to it again and again. It eventually led to his studies on skin temperature and the radiation of heat from the skin.

He contended that man was relatively well equipped to withstand heat, but the mechanisms available for withstanding cold were apparently very poor. Thus he early studied the mechanisms involved in fever and demonstrated the best methods for eliminating excess heat. He and Dr. Coleman followed Dr. Fred Shattuck's earlier methods; DuBois advised feeding typhoid fever patients an adequate diet. This viewpoint was probably influenced by the pathetic hunger of the typhoid patients he had nursed in 1898, when it was thought hazardous to allow such patients to eat solid food. Diet in the treatment of fever continued to arouse his interest, and in 1928 he conducted studies of pure meat and water diet with Vilhjalmur Stefansson, the Arctic explorer. He learned that healthy survival was prolonged only so long as there was ample fat in the meat. Later he became occupied with the diets of Eskimos in the very cold temperatures of northern Alaska. After the Second World War he explored the metabolic effects of changes of temperature on young women.

He first showed, with David P. Barr, that the body could give off as much heat through a cool skin as through a warm one. This was amply proven by a radiometer developed by his later associate, J. D. Hardy. In this same work he stated that the body vasoconstriction could change the skin and subcutaneous tissue into a "suit of clothes," and so regulate heat loss. These were new and important conceptions.

He summarized these scientific contributions as "popularizing the simple, fundamental principles of metabolism in disease so that they found their way into textbooks and habits of thought."

DuBois' whole life was centered around this theme—a theme which was sufficiently fundamental in its approach to allow him to change with great ease in 1941 from Professor of Medicine to Professor of Physiology and Physics at Cornell. However, though this change did not affect his research activities drastically, the impending war distracted him. He already had a military record of remarkable achievement and made frequent contributions to scientific knowledge during the First World War. He worked quietly and, at times, very secretly, so that much of his war work is not fully recognized. He was an outstanding authority in the field of health in submarine warfare and aviation medicine.

In submarine and aviation medicine in the Navy, he experimented endlessly with the physiological effects on man caused by deep diving in submarines and high-altitude flying. He took part in dive-bombing and altitude tests, and worked under fire at the front so he could observe pilots under these stresses. As his wife once said: "He lived to save people, not to kill them."

In the First World War, as a Lieutenant Commander in the Navy, he received the Navy Cross for heroism in the conduct of hazardous experiments. During the Second World War he was given a Commendation and a Ribbon Bar. Certainly the Navy's respect for his scientific knowledge was great. Nowhere was this remarkable amalgamation of clinical medicine and scientific knowledge better utilized than in DuBois' work. His training in calorimetry made it natural that he be assigned to research in deep-sea diving in submarines and aviation and gas warfare; all of these had to do with ventilation and gas exchange.

Toward the end of the First World War he underwent a four-day submergence in a submarine, at that time a record for complete submergence. He probably won his Navy Cross for saving a damaged submarine. The submarine was guarding a four-masted schooner decoy and collided with a second submarine. Everything went wrong—a storm damaged the rigging of the decoy and DuBois proved to be the one to fix it, because he was used to climbing the rigging in fair weather for exercise. He then rowed back and boarded the submarine to treat a man whose arm was broken. A passing American convoy made the submarine dive quickly. Through a leak it shipped salt water in large quantities; this would liberate free chlorine should it come in contact with the batteries. DuBois' laboratory training taught him to set up blowers to drive the air through soda lime cannisters to absorb any free chlorine formed. This act saved the crew from severe poisoning.

The improvement in fundamental medical training which followed the First World War was phenomenal and, as a result of better undergraduate schooling and postgraduate training, good research followed and became progressively easier to do. It was at this time that DuBois was appointed Medical Director of the Second Medical Service at Bellevue Hospital with the request that he reorganize the Service. His constant dedication to meticulous and intelligent experimentation in scientific clinical medicine contributed immeasurably to its rapid development in America. During his thirty-seven years of work he had thirty-three colleagues. Many of them were so influenced by his personality—his enthusiasm, his charm, his generosity—that they continued in medical research and remained in academic medicine. This is no small accomplishment in a field where the clinic beckons and tempts one to leave the laboratory.

In 1937 he gave the distinguished Lane Lectures at Stanford University, at which he took the occasion to summarize his dominating interest, the mechanism of heat loss and temperature regulation. In the preface of the transcript of these lectures he justifies clinical research activities by the phrase: "it is the clinician who has the responsibility of securing for the science of physiology all the information obtainable from Nature's experiments on man." These lectures indicate DuBois' tenacity, as he says, "each small problem that is solved brings up other problems which make it necessary to take another step, and that step is usually backwards into a more fundamental science."

He was made Professor of Medicine and was in charge of the Medical Division of Cornell University at Bellevue from 1930–32. This teaching division and the Russell Sage Metabolism Ward, and calorimeter, were later moved to the New York Hospital. He then had six exciting months on leave with Friedrich von Müller in Munich. After his return he was in charge of medicine until 1941, when he became Professor of Physiology following the resignation of Detlev Bronk, who returned to Philadelphia after only one year's tenure at Cornell. This post was very much to DuBois' liking, for it gave him the promise of freedom from the arduous distractions of the chief in charge of the seriously ill. In 1942 he was called to active military duty.

In the Second World War he was again in uniform as a Captain in the Navy. He had a unique arrangement; six months of each year he was permitted to teach physiology as a civilian. His experiments with high-altitude flying and prolonged submergence in submarines made him the great authority on respiration and environmental physiology. He was particularly involved in the safety of airplane pilots. He tells in his Harvard Fiftieth Anniversary Report that in 1950 he flew from Point Barrow, Alaska to Barter Island "with the temperature fifty degrees below zero. The next week I was submerged in a snorkel submarine near Key West." As he expressed this in a letter to the Editor in the *Annual Review of Physiology* in 1950: "In World War I, there was nothing like the eager demand for research that characterized World War II. It so happened that I served in the Research Division of the Navy's Bureau of Medicine and Surgery in both Wars. At the end of World War I, the Division consisted of two junior officers and two enlisted men. Early in World War II the Division occupied a whole building; there was an Admiral in charge and about eight other senior officers."

In 1942 the Crash Injury Research Program was established at Cornell. This was first financed by funds from O.S.R.D. It was a program in which DuBois was fundamentally interested and, housed in his Department of Physiology, it was concerned with the design of airplane cockpits and other means for minimizing accidents. Safety belts for airplane occupants were recommended by this group. They were not readily accepted, and as late as 1953, DuBois was still trying to demonstrate their value to skeptics. Belts are now universally accepted safety devices.

After the war he returned full time to his Department at Cornell and remained there until his retirement in 1950.

He had a full life in his retirement as a scholar and able administrator on committees. He also kept busy with Dr. Friedrich Gudernatsch. Together they were interested in the metabolism of Eskimos with their unusual diets.

In 1954, a cerebral hemorrhage reduced his physical activities by confining him to a wheel chair. But he retained a very active mind and a wonderful sustained desire to do original work and be useful. His mind continued to focus on scientific problems which engrossed him. In time he became remarkably calm and his forbearance under the trial of inactivity was wonderful to watch. He remained devoted to his friends and indeed devoted to his work. In 1958 he answered a letter of inquiry from the American Physiological Society saying in part that he would be glad to work if he could be useful, but he did not want to take any job which would interfere with the training or advancement of younger men. He died ten months later, February 12, 1959, at the age of seventy-six.

The last paper by Dr. DuBois appeared in the *Proceedings of the American Philosophical Society* in the February, 1960 issue. Characteristically, it dealt with an attempt to classify occupations in relation to the physical exertion demanded, and the physical fitness of the subject. Dr. Walsh McDermott writes in the foreword that this work was terminated half finished because DuBois was "caught in the flood of Hurricane Carol in August, 1954. A few days later he had a stroke and was obliged to stop work while the data were still incomplete."

DuBois had complete integrity and accuracy in his laboratory. He was very meticulous, and he required repeated checking of his experimental data and results. As uncompromising with himself as in the ideals he expected of others, he never asked anyone to act as a subject for an experiment unless he had been subjected to it first. And this was not done with pompousness—DuBois had true humility. With complete honesty he faced life with great confidence and courage, and always with uprightness and modesty.

Just as he struggled to keep his work superior, so he persevered at keeping himself in good physical condition. He always took exercise seriously, rowing on crews as an undergraduate in college. Later, for many years each morning before breakfast he ran a mile. When he was seventy he "tapered off skiing and stopped tennis, but continued to run up many flights of stairs and did not take elevators."

His interests were serious rather than superficial. He took an intense interest in painting and music. When he worked at the Bellevue Hospital he would slip away from the laboratory and walk home so that he might search in the second-hand shops in the Lower East Side. His particular hobby was nineteenth-century American painters, and his purchases gave him great pleasure. As far as I know, they were not great art "finds," but he derived much pleasure from his attempts to restore them.

Dr. DuBois received many honors. He was a member of the more superior medical societies, and at one time or another, he was president of many of these. He was elected a member of the National Academy of Sciences in 1933.

He held the following offices: Instructor in Clinical Medicine and Applied Pharmacology, 1910–11, Professor of Medicine, 1930–41, Professor of Physiology and Biophysics, 1941–50, Cornell University Medical College; Director, Second Medical Division, 1919–32, Bellevue Hospital; Medical Director, 1912–50, Russell Sage Institute; Physician-in-Chief, 1932–41, New York Hospital; Commander, 1919, Captain, 1927, Medical Corps, U.S. Naval Reserve; member of Cornell Committee Air Safety Research, 1947–50; member of National Research Council Committee on Undersea Warfare, from 1947; Chairman, Research and Development Board Panel on Shipboard and Submarine Medicine, 1948–52.

He received the Navy Cross in 1918, and a Letter of Commendation and Ribbon from the Navy Department in 1946. In 1932, he was awarded Commendation from the Department of Hospitals, City of New York for "Distinguished and Exceptional Public Service." He also received the Kober Medal of the Association of American Physicians in 1947; an honorary Sc.D. degree from the University of Rochester in 1948; the Academy Medal of the New York Academy of Medicine in 1956; the Banting Medal of the American Diabetes Association in 1955.

He gave many distinguished lectures: a Harvey Lecture in the 1915–16 series; Lane Lectures in San Francisco, 1937; the Mellon Lectures in Pittsburgh in May, 1948; the California Academy of Medicine in December, 1950, to name a few.

A happy home life contributed in large measure to his success. He was married soon after his internship, in June, 1910 to Rebeckah Rutter of Irvington-on-Hudson, New York. The marriage was a very happy one. She was always aiding him in his work, and made for him a home of great peace and charm. Their children have been successful, and, as one would expect, very generous and thoughtful of others. There was a close relationship between his home and his associates in the laboratory. And his professional associates were as devoted to Reba DuBois as they were to the "Professor."

He spent most of the last five years of his life in a wheel chair. His ready smile was almost gone, but the years appeared to be quite happy ones, partly because of his many loyal friends, but largely because of his devoted family.

KEY TO ABBREVIATIONS

Aeronautical Eng. Rev. = Aeronautical Engineering Review
Am. J. Dis. Child. = American Journal of Diseases of Children
Am. J. Med. Sci. = American Journal of the Medical Sciences
Am. J. Physiol. = American Journal of Physiology
Ann. Int. Med. = Annals of Internal Medicine
Ann. Rev. Physiol. = Annual Review of Physiology
Arch. Int. Med. = Archives of Internal Medicine
Biogr. Mem. Nat. Acad. Sci. = Biographical Memoirs of the National Academy of Sciences
British Med. J. = British Medical Journal
Bull. N. Y. Acad. Med. = Bulletin of the New York Academy of Medicine
Ergeb. Physiol. exp. Pharm. = Ergebnisse der Physiologie biologishchen Chemie und experimentellen Pharmakologie
J. Am. Diet. Assoc. = Journal of the American Dietetic Association
J. Am. Med. Assoc. = Journal of the American Medical Association
J. Biol. Chem. = Journal of Biological Chemistry
J. Clin. Invest.=Journal of Clinical Investigation
J. Nutrition = The Journal of Nutrition
J. Physiol. = Journal of Physiology
J. Wash. Acad. Sci. = Journal of the Washington Academy of Sciences
Mech. Eng. = Mechanical Engineering
Med. Clin. N. Am. = The Medical Clinics of North America
Proc. Am. Phil. Soc. = Proceedings of the American Philosophical Society
Proc. Nat. Acad. Sci. = Proceedings of the National Academy of Sciences
Proc. Soc. Exp. Biol. Med. = Proceedings of Society for Experimental Biology and Medicine
Submarine Ventil. Bull. = Submarine Ventilation Bulletin
Trans. Assoc. Am. Physicians = Transactions of the Association of American Physicians
U. S. Naval Med. Bull. = United States Naval Medical Bulletin

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