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JAMES BATCHELLER SUMNER

1887—1955

A Biographical Memoir by
LEONARD A. MAYNARD

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Biographical Memoir

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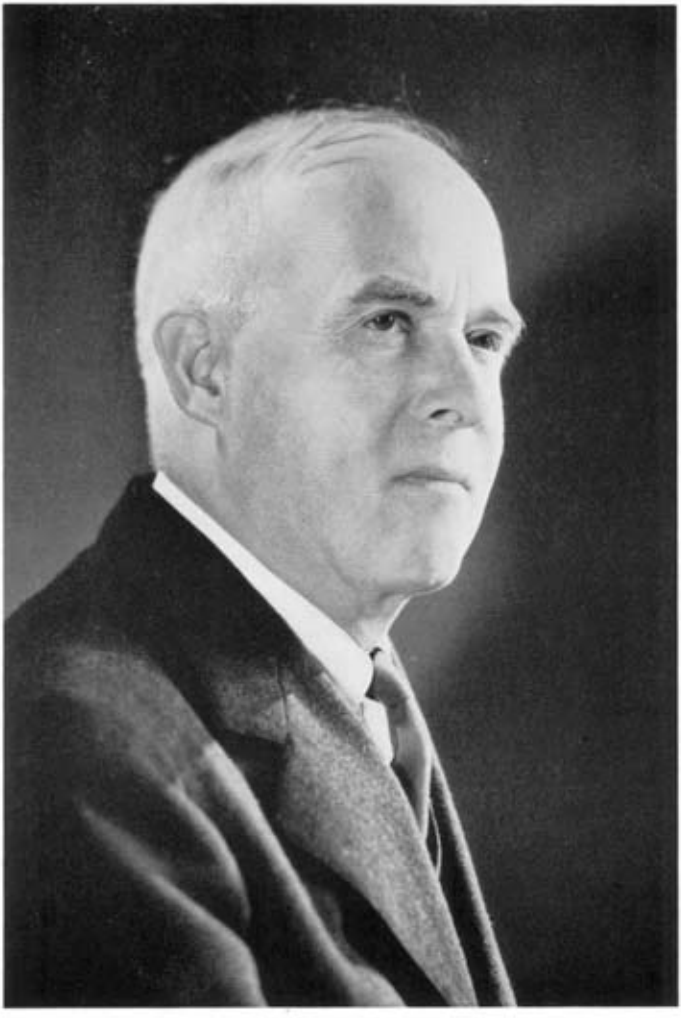

James B. Sumner

JAMES BATCHELLER SUMNER

November 19, 1887—August 12, 1955

BY LEONARD A. MAYNARD

FOR THE past quarter of a century developments in the field of enzymes have proceeded with a rapidly accelerating pace. The pioneer in these developments was James Batcheller Sumner who, in 1926, was the first to isolate and crystallize an enzyme. His announcement of this discovery was first greeted with skepticism, disbelief, and even ridicule by several other scientists working in the field, but Sumner vigorously defended his findings, established further proof, and eventually won full recognition for his discovery. Here he displayed the perseverance, industry, and ingenuity which characterized many other phases of his life.

Sumner was born in Canton, fourteen miles south of Boston, on November 19, 1887, the son of Charles and Elizabeth Rand Sumner. He was descended from a long line of New England forebears. The first Sumner came from Bicester, England, to settle in Boston in 1636, and most of the members of the later generations settled in nearby areas. Thus Sumner was born in the midst of many relatives. They were engaged in manufacturing, farming, and other pursuits. One uncle, Frederick Sumner, was a violinist of distinction. His mother's uncle, James Batcheller, for whom Sumner was named, was a distinguished scholar who was known as "the walking encyclopedia of Marblehead."

His grandfather had a cotton factory and also a farm. Other relatives were engaged in the cotton business and his father had a large country estate. Thus as a boy, Sumner had the opportunity to observe steam engines and knitting machines in operation, and also to observe

cows and horses and farm practices. Evidently he made excellent use of these opportunities, with the curiosity and the eagerness to learn about both machines and living things which characterized his later life.

After a few years' attendance at the Eliot Grammar School, Sumner was sent by his father, who believed in providing the best education possible, to the Roxbury Latin School. This involved, each school day, a trip by train and a two-mile walk going and returning. Here six years were spent in college preparation. Sumner had become interested in science through talks with his uncle, F. W. Sumner, and chemistry and physics were his favorite subjects in school. He joined with a companion, George Goodspeed, in constructing induction coils, electric batteries, and explosive mixtures. The two boys spent a lot of time together talking about science.

As a boy Sumner was much interested in firearms and went hunting frequently. As a result, a very tragic misfortune occurred. His companion accidentally shot him in the left arm, which had to be amputated above the elbow. The accident was the more serious because Sumner was lefthanded. With amazing courage and determination he set out to train himself to get along with one arm instead of two and to use his right in activities for which he had previously used his left only. He had been very fond of several sports and his accident stimulated him to exert every effort possible to excel in all sorts of games. His success was remarkable indeed. He became an expert in tennis, which he continued to play as late as his sixties. At one time he won the Championship of the Cornell Faculty Tennis Club. When he was in Stockholm to receive the Nobel Prize, he was granted a private audience with King Gustav, a fine tennis player despite his age, and the game of tennis came up in their conversation. When the king asked Sumner how he could handle both ball and racket for a serve he gave the king a demonstration. Sumner also became very proficient in skating, skiing, swimming, canoeing, billiards, and clay pigeon shooting. He enjoyed hiking in the mountains and also canoe trips. He climbed the highest peaks in the Adirondacks in New York

State and he took several canoe trips into the far north in Canada. His interests in participating in outdoor sports continued throughout life. The winter before he died he purchased a new pair of ice skates.

In 1906 Sumner entered Harvard College and started to study electrical engineering. Within a few weeks, realizing that he was deficient in mathematical training for this field, and that he really preferred chemistry, he changed his field. As a senior he published, with Professor H. A. Torrey as senior author, his first scientific paper, which dealt with an attempt to synthesize papaverin.

Sumner has described himself as somewhat of a rebel as far as student custom was concerned. As an entering student he smoked a pipe. He was warned by an upperclassman that if he persisted in smoking a pipe on the campus he would lose all chance of joining a club, but persisted, nevertheless, reflecting an individualism which also characterized his later life.

Following his graduation from Harvard in 1910, Sumner started to learn the knitting business under the direction of his uncle, Frederick W. Sumner, who was then manager of the Sumner Knitted Padding Company. The uncle was a stern taskmaster who apparently had some doubt about the usefulness of a college education. His nephew was given such varied tasks as helping unload 500-lb. bales of cotton, running and repairing knitting machines, typing correspondence, and running errands. The work day was ten hours except on Saturdays, and the wages were five dollars weekly.

This employment was terminated after a few months when the opportunity came through Harvard University for Sumner to teach chemistry for one term at Mt. Allison College, Sackville, New Brunswick, with an appointment as Acting Professor of Science. He accepted with alacrity, although he had had no teaching experience. Apparently he taught at least two courses in chemistry, and one in physiology as well. This experience developed in Sumner a confidence in his ability to teach and also a liking for the task, but it also showed him that he needed further training and turned his thoughts to graduate work.

Returning home after a summer trip to western Canada, Sumner accepted an assistantship in chemistry at Worcester Polytechnic Institute, Worcester, Massachusetts. At the end of the first term he resigned to pursue studies for the doctorate in chemistry at Harvard. Since he also wished to obtain further training in physiology, his friends suggested that he should work at the Medical School, majoring in biochemistry with Professor Otto Folin. In an interview Folin suggested to Sumner that he take up law instead, stating that a one-armed man could never make a success in chemistry. This was just the kind of challenge Sumner had been meeting ever since he lost his arm. He was stimulated to prove that this loss was not too severe a handicap and he demonstrated that he could effectively and skillfully carry out the laboratory techniques required both in his course work and in his research. His accomplishments won the admiration and commendation of Professor Folin and, in later years, Sumner paid frequent tribute to the advice and encouragement he received from this distinguished teacher.

He received the A.M. degree in 1913 and the Ph.D. degree in June, 1914. The title of his thesis for the doctor's degree was "The Formation of Urea in the Animal Body." At the end of the thesis the following acknowledgment was made: "I wish to express my gratitude to Professor Otto Folin for the supervision of my work in his laboratory and to Mr. C. H. Fiske for his cooperation in this work carried out with him." Part of this thesis was published by Fiske and Sumner in the *Journal of Biological Chemistry,* Vol. 18 (1914), pp. 285–295.

Following the completion of his graduate studies Sumner sailed for Europe in company with a classmate, R. H. Patch. The trip, which included visits to England and the Continent, proved most enjoyable, despite the rumors of war. The last part of the trip was spent in Switzerland, where E. K. Bolton, who had recently taken his Ph.D. in inorganic chemistry at Harvard, joined the party. While at Interlaken, Sumner received a cablegram offering him an appointment as Assistant Professor of Biochemistry at the Ithaca Division of the Cornell University Medical College. He accepted the appointment im-

mediately, but World War I had begun and it was a month before he could get out of Switzerland, and there were further delays before he reached home. On entering upon his duties, he was given an appointment to the Faculty of the College of Arts and Sciences as well as that of the Medical College.

Thus in the fall of 1914 Sumner began his teaching and research career at Cornell, a career in which he remained active until a few months before his death. For fifteen years he served as Assistant Professor and for nine as Professor in the Department of Physiology and Biochemistry of the Ithaca Division of the Medical College. With the discontinuance of this Division in 1938 he was given an appointment as Professor of Biochemistry in the Department of Zoology of the College of Arts and Sciences. Two years later his activities were placed under the jurisdiction of the College of Agriculture where new quarters were provided, and he was also given an appointment in that College, although without the termination of his appointment in the College of Arts and Sciences. In 1945 a Department of Biochemistry, later named Biochemistry and Nutrition, was established in the College of Agriculture and he was appointed to its staff. In 1947 a Laboratory of Enzyme Chemistry was organized in that department with Sumner as its director. He also held an appointment in the School of Nutrition from its founding in 1941. Thus Sumner was the pioneer in the field of biochemistry at Ithaca and remained the outstanding leader in its development for over forty years.

This period of service was continuous with the exception of periods spent in postdoctorate study. In 1920–1921 he received a Belgian-American fellowship and worked at the University of Brussels Medical School. Although he had planned to study with Effront, he found Effront unsympathetic to the idea of trying to isolate urease, and thus he worked with Edgard Lunz on blood coagulation instead. In 1929 he studied with von Euler at the University of Stockholm and in 1937 he went to the University of Uppsala on a Guggenheim fellowship.

On entering his duties at Cornell, Sumner was assigned the responsibility of giving a lecture and laboratory course in biochemistry to medical students and a course of similar scope, though differing in

subject matter, to students majoring in home economics. He also taught two advanced courses and conducted a seminar. To help him in this heavy teaching load, he had only one graduate assistant. This load remained similar in kind for many years but increased in amount with growing student registration. He never had more than two part-time instructors or graduate assistants. In addition to formal course work the demands upon his time increased with the increased number of graduate students to be served, especially those majoring in other fields who wished to minor in biochemistry. By 1930 there were three graduate majors and twenty-five graduate minors in biochemistry, all under Sumner's direction. These numbers continued to increase in succeeding years. It was not until 1946 that he was relieved of his heavy undergraduate teaching load and enabled to devote his teaching duties primarily to graduate students.

Sumner liked to teach and was an excellent teacher. His lectures were clearly presented in short, meaningful sentences. He did not believe in spoon-feeding his students, but expected them to use his lectures as a basis for expanding their knowledge of the subject through reading and conferences. He demanded that written examinations and reports be expressed in correct English and properly punctuated. He was impatient with sloppy work either in the classroom or laboratory. This impatience sometimes irritated his students, but they had a high respect for him as teacher, particularly in the laboratory, where he showed them how to do things instead of merely lecturing to them, and where his dexterity in manipulating apparatus and equipment with one hand continued to amaze them. In his lectures, Sumner showed his human qualities by frequently telling humorous anecdotes, occasionally about himself. He once expressed his philosophy as a teacher in these words: "The most important things I have tried to give my students are a curiosity to discover the world about them and the integrity to look only for the truth. Students must learn what has gone before them in the past and gain broad rather than too specialized backgrounds if they are really to know where they are going and what they are doing."

In entering on his appointment at Cornell in 1914, Sumner found

the opportunities for research very meager because of the time required for his teaching duties, the scanty equipment available, and the lack of any laboratory helpers. Nevertheless, his eagerness to make some real contributions in the research field, as well as his willingness to devote many extra hours during both the day and evening to that end, led him to embark immediately on a research program. This program was concerned with biochemical analytical methods, a field in which he had become interested while at Harvard. His first paper dealt with the determination of ammonia and urea in muscle and urine. This line of research did not prove very satisfying to him, but he was intrigued by the mysterious problem of the nature of enzymes and decided to try to isolate an enzyme in pure form. In explaining this decision in his Nobel Laureate Lecture at Stockholm in 1948, Sumner stated:

"I wish to tell next why I decided in 1917 to attempt to isolate an enzyme. At that time I had little time for research, not much apparatus, research money or assistance. I desired to accomplish something of real importance. In other words, I decided to take a 'long shot.' A number of persons advised me that my attempt to isolate an enzyme was foolish, but this advice made me feel all the more certain that if successful the quest would be worthwhile."

So began a quest which went on for nine years before the goal was reached. Many more years were to elapse before the findings were generally accepted. Sumner had become interested in urease from his previous studies and he had found the jack bean (*Canavalia ensiformis*) to be a rich, readily available source. Thus this enzyme was selected for study. In the early course of these investigations, various chemical compounds were isolated from the beans, including two globulins which were obtained in crystalline form. Sumner was particularly interested in the proteins of the beans because he felt that enzymes must be protein in nature. Over the years he used a large number of methods and reagents in an attempt to purify urease. At times he became discouraged and temporarily abandoned the quest, but always returned to it again. Finally, by a relatively simple proce-

dure a concentrate was obtained containing tiny crystals which, when centrifuged off, had a very high urease activity in water solution and gave tests for protein. As a result of these findings and further confirmatory studies, Sumner published a paper in the *Journal of Biological Chemistry* in August, 1926, in which he announced the isolation of a new crystalline globulin from the jack bean and presented evidence for his belief that the globulin was identical with the enzyme urease.

The announcement was received with skepticism by most biochemists and with frank disbelief by many. This is not surprising, because the isolation and crystallization of an enzyme was considered an impossible task. Dr. Sumner's findings were particularly attacked by Willstäter and his students in Germany, who tried for years to produce pure enzymes and had concluded that they contained no protein. These German workers dismissed Sumner's claim on the basis that the protein crystallized was merely the carrier of the enzyme. A large and extended controversy ensued. Sumner followed up his original report with some ten additional papers during the next five years, in which he furnished additional data supporting his position and replied vigorously to his critics.

In 1930 important general support for his work and views came from the announcement by J. H. Northrop, working at the Rockefeller Institute at Princeton, N. J., of the crystallization of pepsin, and later by Northrop and Kunitz of the crystallization of trypsin and chymotrypsin. It was some years later, however, before there was general acceptance of the work of Sumner and Northrop and particularly of the fact that enzymes are proteins. This acceptance was recognized in 1946 by the award of the Nobel Prize in Chemistry. One half was given to Sumner "for his discovery that enzymes can be crystallized." The other half was divided between Northrop and W. M. Stanley, then also at the Rockefeller Institute, "for their preparation of enzymes and virus proteins in pure form."

Sumner's enzyme research was by no means limited to urease. With Dounce he crystallized catalase and established its protein na-

ture. His studies also dealt with more than a dozen other enzymes and resulted in several publications. He was also interested in the general field of protein isolation. Mention has been made of his isolation of two proteins from the jack bean prior to the isolation of urease. Later he obtained a fourth one in crystallized state. While on sabbatical leave at the University of Brussels, he prepared, for the first time, fibrinogen entirely free from thromboplastic substance. Throughout his career he continued from time to time to develop and publish new or improved laboratory methods, his original field of research. All told, he published more than 100 research papers and many other articles of a technical or semipopular nature describing his field of interest.

The magnitude of these accomplishments becomes particularly noteworthy when it is realized that until the last quarter of his career Sumner carried a heavy teaching load and had only meager assistance to aid him in his teaching or in research. He performed personally most of the laboratory experiments upon which his research papers were based. Throughout his career he continued to work actively in the laboratory, performing complicated manipulations with his one hand, to the amazement of both colleagues and students. He believed in the importance of individual research without concern about practical results and felt that present-day supporters of scientific research put too little emphasis on helping the individual, compared with the support given to groups of researchers striving for immediate practical results.

Sumner's publications included books as well as his many scientific papers. He wrote a *Textbook of Biological Chemistry* which was published by the Macmillan Company in 1927. With G. Fred Somers, one of his students, he wrote the book, *The Chemistry and Methods of Enzymes,* published first in 1943 by the Academic Press, and now in its third edition. He and Somers were also authors of *Laboratory Experiments in Biological Chemistry,* published in 1944 by the Academic Press and revised and republished in 1949. Sumner and Karl Myrbäck of the University of Stockholm edited a mammoth work en-

titled *The Enzymes, Chemistry and Mechanism of Action,* which was published by the Academic Press as four books, comprising two volumes of two parts each. These volumes appeared over the period, 1951–1952. They totalled some 2,800 pages and contained articles written by seventy-eight scientists. Each article received a careful reading by Sumner. In several cases, where he questioned whether a reported method would work, he tested it out in the laboratory before approving the article in question.

In 1937 while he was in Sweden as a Guggenheim Fellow, Sumner received from the Swedish Chemical Society the Scheele gold medal for his contributions in the field of enzymes. In addition to membership in the U.S. National Academy of Sciences, to which he was elected in 1948, Sumner was honored by election to the Polish Institute of Arts and Sciences and the American Academy of Arts and Sciences. He was also a member of the American Society of Biological Chemists, American Association for the Advancement of Sciences, Society for Experimental Biology and Medicine, Sigma Xi, Phi Kappa Phi, and other associations. He was a frequent attendant at the meetings of the American Society of Biological Chemists and of other scientific societies. However, he disliked programs which consisted of hundreds of papers, and advocated a new type of meeting at which scientists with common interests would sit around large tables at certain hours and merely discuss their problems.

Sumner had many interests outside the laboratory, besides the various sports which have been mentioned. He was an expert photographer and did his own developing and printing. He was a very good cook and frequently startled his Home Economics students by asking them questions about food preparation. A favorite question dealt with the best way to cook bacon to reduce its fat and salt content to a minimum. Sumner was an excellent linguist, reading and speaking German, French, and Swedish. He taught his springer spaniel, "Hunden," for years his constant companion at home and in the laboratory, to respond to commands in Swedish as well as English. For many years Sumner felt that he should not drive a car because of

having only one arm. Later he obtained a driver's license and became recognized as a skillful operator.

In 1915 Sumner married Bertha Louise Ricketts, from whom he was divorced in 1930. Five children, of whom four survive, were born of this marriage. He married Agnes Paulina Lundkvist of Sweden, in 1931, from whom he was also divorced. In 1943 he married Mary Morrison Beyer. Two children, one of whom survives, resulted from this marriage.

In late 1954 and early 1955, Sumner began making active preparation for an assignment to be undertaken upon his retirement from the University. He had agreed to spend a year or more at the Medical School of the University of Minas Gerais, Belo Horizonte, Brazil, organizing a laboratory and starting a research program in the field of enzymes. He concentrated on the study of Portuguese for six months. He made lists of prices of apparatus and equipment to be ordered and delivered in advance of his coming. He arranged to dispose of his house in Ithaca and to move his family to Brazil. All of these plans came to naught when illness struck him in the spring of 1955.

On May 25–26, 1955, Cornell University held a symposium in joint honor of Sumner and of L. A. Maynard, who were retiring on July 1. At this symposium, former students of both men presented papers dealing with either biochemical or nutritional topics. At the dinner meeting Sumner gave a short speech and charmed his audience with his philosophy and his wit. This was an amazing performance, since he was in pain at the time and undoubtedly knew that he had only a short time to live.

Actually, he was taken to the hospital the next day and never returned. He died of cancer on August 12, 1955, at the Roswell Park Memorial Institute, Buffalo, New York.

KEY TO ABBREVIATIONS

Ann. Acad. Sci. Fennicae = Academia Scientiarum Fennicae Annales
Ann. N. Y. Acad. Sci. = Annals of the New York Academy of Sciences
Ann. Rev. Biochem. = Annual Review of Biochemistry
Arch. Biochem. = Archives of Biochemistry
Arch. Biochem. Biophys. = Archives of Biochemistry and Biophysics
Ber. Deut. Chem. Ges. = Berichte der Deutsche Chemische Gesellschaft
Biochem. J. = Biochemical Journal
Biochim. et Biophys. Acta = Biochimica et Biophysica Acta
Compt. rend. Soc. Belge Biol. = Comptes Rendus des Séances de la Société Belge de Biologie
Compt. rend. Soc. Biol. = Comptes Rendus des Séances de la Société de Biologie
Ergeb. Enzymforsch. = Ergebnisse der Enzymforschung
Ind. Eng. Chem. = Industrial and Engineering Chemistry
J. Am. Chem. Soc. = Journal of the American Chemical Society
J. Am. Leather Chem. Assoc. = Journal of the American Leather Chemists Association
J. Bact. = Journal of Bacteriology
J. Biol. Chem. = Journal of Biological Chemistry
J. Chem. Educ. = Journal of Chemical Education
J. Immunol. = Journal of Immunology
J. Nutr. = Journal of Nutrition
J. Wash. Acad. Sci. = Journal of the Washington Academy of Sciences
Proc. Am. Soc. Biol. Chem. = Proceedings of the American Society of Biological Chemists
Proc. Soc. Exper. Biol. Med. = Proceedings of the Society for Experimental Biology and Medicine
Quart. Chicago Med. School = The Quarterly, The Chicago Medical School
Soc. Biol. Chem., India = Society of Biological Chemists, India
Zeit. Physiol. Chem. = Zeitschrift für physiologische Chemie

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