Martin Gibbs

1922–2006

BIOGRAPHICAL *Memoirs*

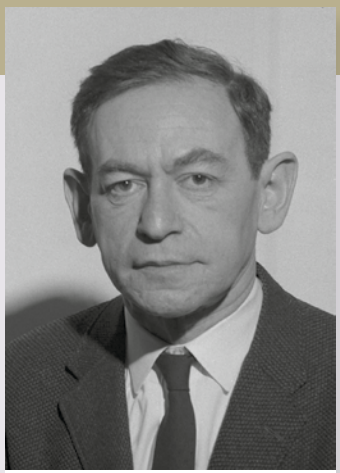
A Biographical Memoir by
Maarten J. Chrispeels

NATIONAL ACADEMY OF SCIENCES

MARTIN **GIBBS**

November 11, 1922–July 24, 2006

Elected to the NAS, 1974



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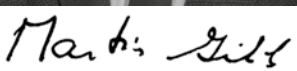

By Maarten J. Chrispeels

Martin Gibbs had three careers. He helped elucidate the path of carbon in the plant cell (synthesis and degradation of sugars); for 29 years he was the editor-In-chief of *Plant Physiology*, the premier journal in the field of plant biology; and for his entire career he was an untiring ambassador for plant physiology and photosynthesis research. Much has already been written about his career and contributions. Clanton C. Black, one of his many students, wrote a detailed tribute to Martin Gibbs and an account of his life and research for the newsletter of the American Society of Plant Biologists (Black, 2006) and another one published in *Photosynthesis Research* (Black, 2008). In addition, there is a separate and very detailed account of the early part of his career at Brookhaven National Laboratory (Black and Govindjee, 2009). Gibbs himself wrote a prefatory chapter for the *Annual Review of Plant Physiology and Plant Molecular Biology* about his life (Gibbs, 1999).

Becoming a scientist

Martin Gibbs was born on November 11, 1922, in Philadelphia, Pennsylvania, into a family of modest means that had two sons. He graduated from the all-male Central High School in 1940, having taken biology, chemistry, physics, and math courses as well as Latin and German. He received a monetary award for his performance in chemistry, and this cemented his decision to major in chemistry in college. He attended the Philadelphia College of Pharmacy and Science, a venerable institution that is the oldest college of pharmacy in North America, where he took a specialization in chemistry. He held various jobs while completing his bachelor's degree in three years under an accelerated wartime program. During his last year, he took a course in pharmacognosy. Martin credited the field trips conducted by Theodor P. Haas, a former curator at the Munich-Nymphenburg Botanical Institute, with sparking his interest in plants. Haas took his students on trips to identify plants with interesting medicinal properties. After graduating in 1943, he

attended the meeting of the American Chemical Society in Pittsburgh, registered with the placement service, and was offered a position as a teaching assistant in chemistry at the University of Illinois in Urbana. The chemistry department was populated by illustrious chemists, including Reynold Fuson, William Rose, and Frederick Wall. But Martin quickly realized that the biochemists had no interest in studying plants, so he transferred to the Department of Botany, where he had a research assistantship analyzing plant samples for their mineral content. His salary ($750 per year) was paid from a grant to F. Lyle Wynd, who was his nominal adviser. During this time, he overlapped with Arthur Galston and G. Ray Noggle, who would remain lifelong friends. After Wynd went to the University of Wisconsin, Harry Fuller became Martin's official doctoral adviser. As luck would have it, D. D. DeTurk in the Department of Agronomy needed a research assistant, and Martin analyzed more samples trying to relate mineral content to soil fertility.

As was common in those days, Martin's thesis topic was different from the work he did as a research assistant. Building on Ray Noggle's work on ploidy and the lectures of John T. Buchholz on plant morphology, Martin chose as his dissertation topic the chemical changes during the growth of diploid and tetraploid *Datura stramonium* (jimson weed). He finished his thesis in May 1947, earning a Ph.D. in botany with minors in chemistry and agronomy.

While in Urbana, he was a member of the graduate scientific fraternity Gamma Alpha and stayed at the house where 15 years later I also spent four happy years. During this time Martin met and courted Karen Kvale, an undergraduate student, who became his wife a few years later (October 11, 1950). Upon graduating from the University of Illinois, he had a sheepskin, but no job, having been consumed by the need to write a dissertation and earn a living as a research assistant.

Brookhaven National Laboratory and the peaceful uses of radiation: 1947-1956

Robert Emerson, newly arrived at the Department of Botany in Urbana, advised Martin to write to David Goddard, Ray Dawson, and Kenneth Thimann. None of them had a position available but Thimann advised Martin to send his resumé to the Brookhaven National Laboratory. The BNL was housed in the facilities of Camp Upton, which had been decommissioned in 1946 and turned over to the U.S. Department of Energy, which promptly leased it to a consortium of Ivy League universities to create science laboratories. One of Brookhaven's mandates was to explore the peaceful use of radiation.

Gibbs had a job but no lab and no equipment. An existing building was converted to a lab, and Gibbs spent the winter of 1947-1948 commuting to New York City to read papers so he could design the apparatus (chamber and vacuum lines) he would need to start his experiments.

While on a bicycling vacation in New England in the summer of 1947, Martin picked up a letter at the Boston Post Office asking him to come for an interview at Brookhaven. He went for the interview, was hired, and started in September as a junior scientist in the Department of Biology. During his first interview with the department chair, Leslie P. Nimms, Martin was informed that it would be his job to synthesize radiocarbon-labeled simple sugars and supply them to the researchers of the Associated Universities consortium. Barium carbonate was then the only radioactive compound available and it seemed logical to make sugars from radioactive carbon dioxide through photosynthesis. This assignment started Martin Gibbs's lifelong love affair with sugar metabolism—both synthesis and degradation—and photosynthesis.

Gibbs had a job but no lab and no equipment. An existing building was converted to a lab, and Gibbs spent the winter of 1947-1948 commuting to New York City to read papers so he could design the apparatus (chamber and vacuum lines) he would need to start his experiments. The first scientific problem they encountered was to localize the ^{14}C in the sugars they isolated from the plants exposed to radioactive carbon dioxide. This problem was solved by his first postdoc, Ralph DeMoss, and I. C. ("Gunny") Gunsalus, who was DeMoss's professor and came for a visit with his student. They brought a culture of *Leuconostoc mesenteroides*, which has a mode of glucose fermentation that produces one molecule of carbon dioxide (from carbon 1 of glucose), one molecule of ethanol (from carbons 2 and 3), and one molecule of lactic acid (from carbons 4, 5, and 6). This proved to be a real advantage over the method used until then which relied on fermentation by *Lactobacillus casei*.

After the Leuconostic method was published, it became the standard and resulted in many collaborations with plant and mammalian biochemists, all interested in intermediary metabolism. Bernard Horecker from the National Institutes of Health used the method to elucidate the pathway from pentose phosphate to hexose phosphate with extracts of rat liver. Later he came to Brookhaven to repeat those experiments with the roots and shoots of pea plants and found that root extracts gave the same labeling pattern

as liver extracts, but leaf extracts did not. The difference could be explained only after Melvin Calvin, Andrew Benson, and their collaborators elucidated the carbon dioxide assimilation pathway of photosynthesis.

Shortly after the Calvin-Benson cycle was elucidated, Gibbs was paid a six-month visit by Otto Kandler, a contemporary from the University of Munich, who became a lifelong friend. Kandler was skeptical of the work and, together with Gibbs, carried out short-term $^{14}CO_2$ experiments to test the new pathway. Applying the *L. mesenteroides* technique, they surprisingly found, first with *Chlorella* and then with leaves, that the label in newly formed hexoses was at odds with the operation of the proposed cycle. This finding was confirmed initially by Achim Trebst and in a follow-up study by Gibbs (then at Cornell) and his student Evelyn Havir—both groups using isolated chloroplasts. Although confirmed several times in different laboratories in the ensuing decades, this atypical labeling pattern, known as the "Gibbs effect," is yet to be explained.

Gibbs collaborated with Harry Beevers (elected to the National Academy of Sciences in 1969), who later also became a major figure in plant metabolism to investigate the presence of the hexose monophosphate shunt in plant extracts. They found that the classical Embden-Meyerhoff-Parnas pathway for hexose breakdown predominated in juvenile and undifferentiated tissues, but the hexose monophosphate shunt became increasingly pronounced during differentiation and aging.

College of Agriculture at Cornell University: 1956-1964

In spite of having produced radioactive sugars for numerous scientists (his assignment) and having had a productive research career (33 publications), Martin was informed by his chair that his contract with Brookhaven would not be renewed. Not a happy day for a man of 34 with a wife and three children. Luckily Harold Williams, head of biochemistry at Cornell University, was on a sabbatical semester at Brookhaven and offered Martin a position as associate professor. So, in the summer of 1956 the Gibbs family departed for Ithaca. He had to develop new skills: teaching courses, advising undergraduates and graduate students, and writing grant proposals. Cornell attracts first-class graduate students, so his productivity benefited from a steady stream of excellent students and postdocs. The Gibbs lab worked on a variety of topics but always in the area of metabolism (photosynthesis or respiration) in either plants or algae, using whole organisms, isolated organelles, or reconstituted systems.

After arriving at Cornell, Martin started to branch out into other rapidly developing areas of photosynthesis, including the two-light reactions (discovered by Robert Emerson and Eugene Rabinowitch) and photophosphorylation (elaborated by Daniel Arnon and his students). He capitalized on the discoveries made in other laboratories, showing that it was possible to isolate active chloroplasts. Louise Anderson worked out the pathway for caffeine biosynthesis in plants. Charles Fewson with Clanton Black elucidated the coupling between photophosphorylation and electron transport with ferredoxin (then called "PPNR," or photosynthetic pyridine nucleotide reductase) as the electron acceptor, and the lag in ATP synthesis with $NADP^+$ reduction. A large number of students and postdocs passed through the Cornell lab (for a list see Black, 2008) and many made excellent careers in photosynthesis research.

Brandeis University: 1964-1994

In the fall of 1964 Martin Gibbs moved his family to Lexington, Massachusetts, having accepted a position as professor of biology at Brandeis University. The family's fourth child had been born in Ithaca and a fifth one would be added in Lexington. The Gibbs lab would be housed in the school's new science complex. Shortly after arriving he was appointed as the Abraham S. and Gertrude Berg Professor of Biology. It is likely that the promise of an endowed chair and the entreaties of his longtime friend and Brandeis faculty member Jerome A. Schiff convinced Martin to move. Earlier when Gibbs was on a sabbatical leave in Philadelphia, Gibbs and Schiff had collaborated on a review on chemosynthesis. Now they became colleagues, renewed their friendship, and exchanged ideas almost on a daily basis. At this time the symptoms of multiple sclerosis of Martin's wife, Karen, became more severe, and caring for her for nearly four decades must have taken its toll. Jerry Schiff proved to be a steady friend and intellectual peer when Martin needed it.

The Gibbs lab continued to attract a steady stream of outstanding visitors from abroad, including France, the Soviet Union, Israel, Germany, Bulgaria, Hungary, Great Britain, and Australia (see Black, 2008, for a listing). Research was focused on chloroplast metabolism in the dark and in the light.

Since the early days in Brookhaven, Martin had been interested in the fates of triosephosphates; it was of course known that they were the first product of carboxylation, but how could one account for the observed C14 labeling patterns? Enzymology was king in those years, and work by Roy McGowan, Graham Kelly, and Erwin Latzko on triosephosphate

dehydrogenases demonstrated a multiplicity of activities: NAD^+ and $NADP^+$ linked reversible and nonreversible, phosphorylating and non-phosphorylating enzymes.

Gibbs was not a believer in the proposed route for glycolate biosynthesis during photorespiration and his associates searched for alternate pathways to make glycolate. They also worked on the influence of hydrogen peroxide and osmotic pressure on chloroplast activities. He also tried his hand at solving the oxyhydrogen reaction originally discovered by Hans Gaffron. Gaffron discovered that cyanobacteria and some algae could evolve hydrogen gas in the light, and in the dark assimilate carbon dioxide and take up hydrogen gas. The work at Brandeis showed that the C3 cycle is involved in carbon dioxide fixation under these circumstances, but how and where the electrons from hydrogen are fed in was not revealed. In 1994, two years after ending his reign as the editor-in-chief of *Plant Physiology*, Martin Gibbs closed his lab, stopped teaching, and accepted retirement.

During his time at Brandeis, he was honored numerous times for his scientific achievements, including election to the American Academy of Arts and Sciences in 1971 and to the National Academy of Sciences in 1974. He received awards from the alumni associations of his two alma maters: the Philadelphia College of Pharmacy and Science in 1981 and the University of Illinois College of Liberal Arts and Sciences in 1996. Many other awards honored his research in carbon metabolism and his service to the plant sciences (see Black, 2008).

Editor-in-chief of *Plant Physiology*: 1963-1992

The long and very successful tenure of Martin Gibbs as the editor-in-chief of *Plant Physiology* is probably his major legacy to plant biology. It is remarkable that he took on this responsibility when he was still a young man of 41 and in the middle of an active research career. Under his leadership the journal saw phenomenal growth in submissions and in articles published and became the place to publish excellent research in plant physiology. As submissions grew by more than sevenfold Gibbs gave up reviewing and making the decision on every paper himself; he appointed associate editors and expanded the editorial board. The growth of the journal paralleled the growth of science funding in the United States. Starting in 1975 more and more submissions came from abroad in part because of Gibbs's many connections to plant physiologists in other countries. The editorial board members met for a working session at the annual meeting of the American Society of Plant Physiologists, and the dinner that followed this meeting became the social event of the meeting.

When Martin Gibbs stepped down as editor-in-chief in 1992, the society organized a grand event at its annual meeting. That year Gibbs was awarded the Adolph A. Gude award for outstanding service to the science of plant physiology. As publishing the journal was one of the two major activities of the society, Gibbs also had a major role in the society's growth. As editor-in-chief he had a permanent seat on the Executive Committee. While all others on the committee came and went, Gibbs provided the institutional memory. The role of Martin Gibbs in the growth of the society is detailed in a monograph by John B. Hanson on the history of the society (Hanson, 1989). In appreciation of his research and service for 30 years as chief editor of *Plant Physiology*, the society honored him by issuing the Martin Gibbs Medal, to be awarded to a distinguished plant scientist. The recipient of the medal is invited to organize the Martin Gibbs Symposium for the next national meeting.

As the editorial board grew, Gibbs started meeting with the associate editors in the winter. In the late 1970s those meetings shifted to Riverside, California, where Martin would take up residence for the month of January, escaping the New England winter. The University of California, Riverside, faculty suggested that they organize a small symposium that would include the associate editors and some local faculty members. This initiative has grown to become a major plant biology symposium, which is now held every two years.

Toward the end of the 1980s new initiatives were needed because new plant disciplines became prominent (cell biology and signal transduction, molecular biology and gene cloning, molecular genetics) as more traditional biochemical approaches began to become less important. ASPP (now the American Society of Plant Biologists) started a second journal (*The Plant Cell*) under the leadership of Robert Goldberg, and I took over as editor-in-chief of *Plant Physiology* in 1992, having been first a member of the editorial board and then an associate editor. I lasted only seven years. To this day I do not understand how Gibbs lasted 29. Those who knew Martin understand that his legacy is complex, as it is for many of the larger-than-life figures of his era. However, there can be no doubt that he had a huge impact on *Plant Physiology* and that during the early years of his leadership, he laid the foundation for the journal to become the top broadly based plant biology journal in the world, the journal to which others aspire.

International plant physiology ambassador to Eastern Europe: 1950-1992

Gibbs cultivated many international connections, especially with scientists in Eastern Europe. His genial personality and his genuine interest in everyone's life circumstances allowed him to easily connect with people on a personal level. In 1950 Martin was given the opportunity to organize the first Brookhaven conference (Carbon Dioxide Assimilation Reactions in Biological Systems). Quite an assignment for a young man three years after obtaining his Ph.D. He invited the best and brightest as speakers and met all other U.S. and foreign attendees. Three future Nobelists participated: Otto Meyerhof, Severo Ochoa, and C. B. Anfinsen, as well as many prominent plant biologists. This fortuitous happening and the fact that his radioactive sugars resulted in many collaborations set the stage for later international connections. He received an invitation to participate in the 1954 International Botanical Congress in Paris (France). Prior to the Congress he visited scientists in England, the Netherlands, France, and Germany. In Munich he made the acquaintance of Otto Kandler, and this resulted in a fruitful collaboration using the Leuconostoc procedure. In 1959 he attended the International Botanical Congress in Montreal and renewed his acquaintance with his international friends, especially with Alexis Moyse from Gif-sur-Yvette, France. By Gibbs's own account (Gibbs, 1999), his enduring friendship with Moyse is what got him elected to the French Academy of Sciences.

In Montreal he met two Russian scientists who assured him that a section on photosynthesis would be included in the 1961 International Congress of Biochemistry in Moscow. A few years earlier (in 1958) the Soviet plant physiologist N. G. Doonan from the Academy of Sciences of the U.S.S.R. had spent a week in the Gibbs lab. At the Moscow Congress he met others and again used the occasion to visit laboratories, including the lab of Oleg Zalensky whose research was internationally recognized. He also visited with the editor of the *Soviet Botanical Journal*, and in Lund, Sweden, he visited Hans Burstrom and Anders Kylin, the editors of *Physiologia Plantarum*. When Martin later became editor-in-chief of *Plant Physiology* he would remain in contact with these and many other editors of plant biology journals.

In 1972 he traveled again to the Soviet Union—to Dushanbe, Tajikistan—to attend a symposium on the genetics of photosynthesis. This allowed him to meet again his many friends in the Soviet Union and to visit the Vavilov Institute in the foothills of the Pamir Mountains. In 1975 Gibbs was a vice president of the International Botanical Congress in Leningrad. Given his expertise in Soviet plant science, he became a member of the

Eastern European panel of the Council for the International Exchange of Scholars, which administers the Fulbright Program. He served on this panel for 10 years (1973-1983) and traveled widely in the Soviet Union (see Gibbs, 1999). On each trip he gave seminars, met with faculty and students and broadened his contacts in Eastern Europe. In 1982 and again in 1986 he helped organize Hungary-USA bi-national symposia on photosynthesis. The first one was in Szeged, Hungary, and the second one in Newport, Rhode Island. In 1992 Gibbs co-organized with V. V. Shuvalov a Russian-U.S. workshop on photosynthesis sponsored by the Soviet and U.S. Academies of Sciences.

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