BIOGRAPHICAL MEMOIRS

Martin David Kamen

August 27, 1913–August 31, 2002
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A Biographical Memoir by John Abelson

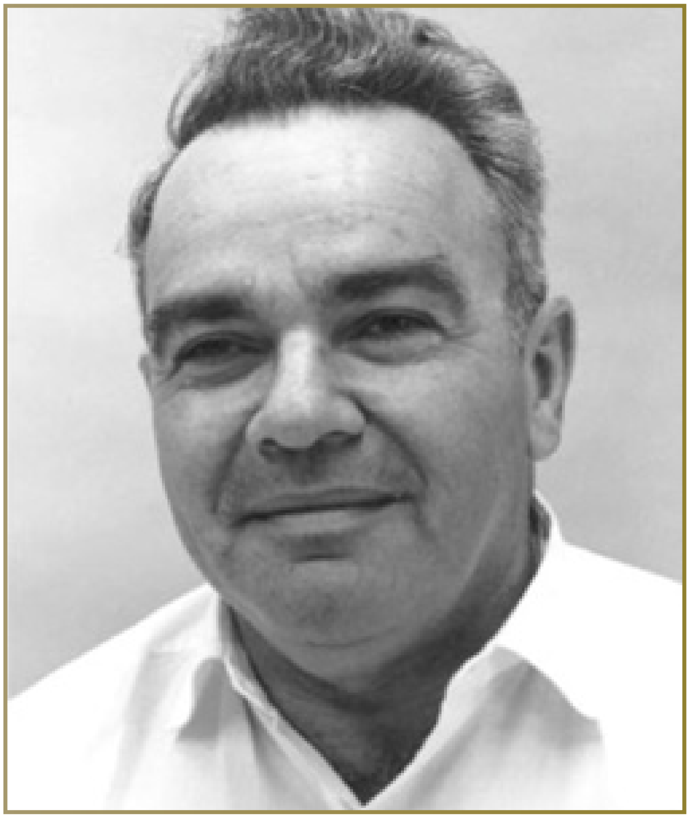

Figure 1 Martin D. Kamen.

Martin D. Kamen is best known for his discovery of the isotope ^{14}C. His work established the use of radioactive compounds ("tracers") to track the intermediates in and products of numerous metabolic pathways and the biosynthesis of biological macromolecules, thereby revolutionizing biochemistry and molecular biology. Second, he is renowned for the demonstration that all the oxygen released in photosynthesis comes from water. This discovery was surprising because it takes an enormous amount of energy to remove electrons from water. Later, he made many major contributions to the study of bacterial and mitochondrial cytochrome c and other biological electron carriers.

Kamen's father Aaron had emigrated to Toronto, Canada, from Slonim, Russia, (now in Belarus) in 1906 escaping from Tsarist police who wanted to arrest him because of his membership in Karensky's Socialist Revolutionary Party. Martin was born in Toronto in 1913, although the Jewish family had earlier moved to Chicago. (His mother believed that medical care was better in Canada.) As in many immigrant families, there was pressure for Martin to succeed. He was a natural musician and played the viola in orchestras by the age of nine, an avocation he continued for his entire life.

Because Martin was an excellent student in high school, finishing in three years, he easily gained admission to the University of Chicago in 1930. At first Martin was an English major while at the same time playing in chamber music and orchestras all over the Chicago area. But as the Great Depression deepened in 1930, Martin's father (a reader of magazines like *Popular Mechanics*—with articles like "Be a Chemist and Make Millions") urged that he switch his major to science. He became a chemistry major, and his skill in mathematics facilitated much of his success.

Kamen remained at Chicago for graduate school, focusing on physical chemistry. The oral exam that is required before graduate students are allowed to continue with their doctoral dissertation research is a rite of passage and a barrier that is anticipated with fear and loathing. (That was certainly this author's experience.) When he went into his exam, Kamen was relieved to find that Morris S. Kharasch, an organic chemist and chair of the department was not there. The exam was going well until Kharasch returned from a trip and walked into the exam room. The friendly atmosphere disappeared, as the new arrival quickly began asking questions, a few of which Kamen could answer. Then Kharasch began asking questions about how one goes about transforming organic amines to organic alcohols starting with methylamines. This line of questioning did not go well, especially when they got to the three-carbon n-propylamine. This was a trap. One- and two-carbon amines only give rise to linear carbon alcohols and nitrogen gas; but the three-carbon n-propylamine can give rise to both n-propanol and the branched isopropanol. Kamen answered: "You'd expect to get normal propyl alcohol, but that's not saying what you'd get." Kharasch broke in with, "Don't you think organic chemistry is a science?" and Kamen replied heatedly, "No! It's a black art!," whereupon Kharasch angrily left the room. The outcome was that to pass Martin had to study organic chemistry for six months. This story is worth recounting here because few graduate students would have had the intellectual self-confidence Kamen displayed in that exam.

In search of a thesis project, Kamen came up with a very physical problem—the scattering of protons by high-energy neutrons. He failed to get usable results using the Chicago cloud chamber but began to accumulate useful data after switching to photographic emulsions. Meanwhile his personal life was like a rollercoaster ride. He had his first relationship (it lasted five years), and his mother died in a car accident. Finally, during a visit, the great physicist Eugene P. Wigner told Kamen to publish his data. The paper appeared in the *Physical Review,* and Kamen received his Ph.D. He had spent only six years at the University of Chicago. He then did what a lot of bright young physicists were doing. He packed his bag and, with the little money he had, bought a ticket for San Francisco to join the laboratory of Ernest O. Lawrence at the University of California, Berkeley.

On his arrival in Lawrence's lab, one of the first people Martin met was this author's uncle Philip H. Abelson, then a graduate student. The main job for everyone in the Lawrence group was to keep the cyclotron running, and if it broke down at night, graduate students and newly arrived postdocs had to find and seal the vacuum leaks. The cyclotron optimally ran twenty-four hours a day, and one of its primary uses was to make radioactive atoms that could be used in medicine. ^{32}P was in most demand. The background radiation in the building was enormous. On one occasion they were having a particularly hard time with an erratic drift in the background rate of radiation. "After much futile effort to find out what was causing it, Phil noticed that the drift was associated in some way with my movements around the room," recollected Kamen. "Ordering me to remove my pants and stand in the corner, he took them (the only pair I had) and gingerly approached the [radiation detection] apparatus. Sure enough, radiation was coming from my pants! We localized it on the fly, where apparently a large amount of ^{32}P had accumulated."

Early on at Berkeley, Kamen met the smart and energetic graduate student Samuel "Sam" Ruben, and they began a collaboration. None of the physicists in the Lawrence group were interested in biology, but Kamen and Ruben realized that radioactive elements could be used to study biological pathways. The first problem they attacked was glucose metabolism. First, they used plants exposed to carbon-labeled CO_2 to produce radioactive glucose, which they could then isolate. The carbon isotope ^{11}C could be made by bombarding boron oxide with deuterons (the nucleus of deuterium, one proton and one neutron), but ^{11}C has a half-life of only twenty-one minutes. The ^{11}C-labeled CO_2 was made in the cyclotron, which was located near the top of a hill above the UC Berkeley campus. They then would dash down the hill to the biochemistry lab, where they exposed the plants to it and then, after a period of time, isolated the glucose. This was feasible but impractical, because so little glucose was made. A better plan, they realized, was to study photosynthesis itself. Although possible, such studies also had to be done fast, and, furthermore, at the time, no one had yet devised good techniques to isolate and identify the photosynthetic products. Even paper chromatography had not yet been invented.

By 1939, Kamen and Ruben realized that they had done all that they could do to study photosynthesis with the short-lived $^{11}CO_2$. By that time, however, everyone had realized the power of using such radioactive "tracers" to elucidate biochemical pathways. Kamen was surprised when he was told by Lawrence that he had the top priority to use both of the two Berkeley cyclotrons to try to find a long-lived carbon isotope. Success was finally achieved on February 27, 1940, after a one-month exposure of graphite to deuterons brought to very high energy in the cyclotron. After a month of late nights running the cyclotron, Kamen left bleary eyed and disheveled shortly before dawn. On his way home, he was picked up by the police as a likely suspect for a mass murder committed a few hours earlier somewhere in the East Bay. He must have looked the part, with eyes red-rimmed from lack of sleep, unsteady gait from weariness, and a three-day growth of beard. After being taken to the station, a survivor of the massacre stared at him, but fortunately gave no sign of recognition. He was released and crawled home, where he collapsed and finally slept for the first time in several days.

By the next day, Sam had burned the graphite sample to CO_2, bubbling it through a calcium hydroxide solution to form insoluble $CaCO_3$. The radioactivity in this precipitate was just over background, but in repeat counts, it was clear that it had a long half-life. A repeat of the whole month-long procedure was needed, but they wrote a short note and Lawrence wanted to publish it. He had just won the Nobel Prize in Physics (1939) and proudly announced the result at a press conference. Clearly, though, bombarding carbon itself was not a procedure that could yield high quantities of ^{14}C for research. In principle, ^{14}C could be formed by the reaction:

$$^{14}N + n \rightarrow {}^{14}C + p$$

To test this idea, Kamen placed several large carboys containing an ammonium nitrate solution next to the deflector, from which a great stream of neutrons poured when the sixty-inch cyclotron was operating. The carboys sat there for two months. Then, Kamen brought them down the hill to their small lab. Hoping that some of the ammonium nitrate had been converted to volatile ammonium carbonate, they ran a stream of CO_2-free air through the carboys and a combustion train, bubbling the effluent vapor through a solution of $Ca(OH)_2$ to capture any resulting CO_2 as the insoluble $CaCO_3$ precipitate. When an aliquot of the dried precipitate was placed in the radiation detector, the counter went off scale. They were amazed to find that many microcuries of ^{14}C had been generated. They had found an efficient means to produce this long-lived isotope.

World War II had begun in Europe in 1939, and all scientific research in Lawrence's Radiation Laboratory ("The Rad Lab") slowed down and then stopped after Pearl Harbor and the entry of the United States into the conflict on December 8, 1941. Thereafter, lab staff conducted only research for the war effort. There were many facets to the scientific work being done to support the war effort, but it was policy that those working on one project did not know what was going on in any other project. In testimony taken later, Kamen described the hardships caused by this policy, especially for scientists who previously had thrived on the open exchange of ideas and results. On one occasion at what is now Oak Ridge National Laboratory, Kamen was asked to create some radioactive sodium by neutron bombardment of salt. He was not supposed to know that there was huge nuclear reactor at Oak Ridge, but he did; so, he asked someone with clearance to expose his sample to a neutron source. When the irradiated sample was returned to him, Kamen opened the lid, and saw that the contents glowed blue—the sample had been exposed to a source of neutrons thousands of times greater than what could be obtained from the cyclotron in Berkeley. At that point, Lawrence and his Army guard happened to come by. Kamen excitedly told Lawrence that, as a neutron source, the cyclotron was passé and explained to him how and why he had reached that conclusion. According to Kamen, Lawrence walked on without comment.

Because of his violation of protocol there, Kamen was labeled a security risk. It did not help that during this period Kamen, via some of his musical friends, became involved with a group of leftists. He played in benefit concerts for groups like the Anti-Fascist Refugee League and the Soviet-America Friendship Association. At a party at the home of the great violinist Isaac Stern, Kamen met the Russian Consul and Vice Consul, who were stationed in San Francisco. They said they wanted help finding a source of ^{32}P for treatment of a Russian colleague in Seattle who had leukemia. Although Kamen could not help them with the ^{32}P, he had dinner with two Russians, Vice-Consul Grigori Kheifetz, who was leaving San Francisco, and his successor Gregory Kasperov. It was a relaxed and convivial two-hour dinner in San Francisco at Bernstein's Fish Grotto (a popular establishment from 1912–1981). It turned out, however, that the Russians were also known KGB spies and that Kamen's dinner with them was shadowed by an American security detail. This incident, although completely innocent on Kamen's part, led nonetheless to his eventual dismissal from the Berkeley Rad Lab in July 1944.

It had been a bad period for Kamen in other respects. His companion and collaborator Sam Ruben was working on the dispersal kinetics of phosgene gas. It came in vials, and for transfer they froze it. Ruben insisted on doing all the dangerous steps himself. While handling a sample that was not quite frozen, the container broke and he inhaled phosgene. He died the next day (September 28, 1943). Kamen was devastated by the premature death of his close friend and research partner. Also, Kamen's marriage to his first wife, Esther, had ended in divorce in 1943.

After his firing from Berkeley, Kamen submitted many applications for research positions in industry. He was usually accepted, but later informed that he could not be hired. He must have been on an official blacklist. He finally got a job as a test inspector at the Kaiser Shipyards. In 1945, he received an offer of a tenure track position in the medical school of Washington University in St. Louis. They had acquired a cyclotron, and Lawrence heartily supported Kamen's candidacy. Kamen had made many close friends in the Bay Area both in science and in music, and they organized a goodbye party. When he arrived, he was surprised to find that they had enough musicians to play Hayden's Farewell Symphony, which, of course, featured Kamen on his viola.

Even though World War II had ended, Kamen continued to be plagued by federal suspicion. But instead of the Army, it was FBI agents who were reading his mail, tapping his telephone, grilling him, and even ransacking his apartment. When interrogated, agents would question him for several hours, checking his answers by reference to a thick book, his dossier. It was evident that the FBI remained convinced that

Figure 2 Martin Kamen playing the viola, 1948. *Acme Telephoto*.

by persistent probing they could eventually uncover something incriminating. "The dossier grew, and so did my apprehension. I had become a latter-day Damocles—a guest at a sumptuous banquet over whose head hung a sword held by a thin thread," recalled Kamen.

In his first year in St. Louis, Kamen was kept busy supplying radioisotope-labeled compounds for medicine and the experiments of others, instead of being allowed time to pursue a fundamental research problem of his own. Then, in 1945, Howard Gest joined Kamen's lab. Kamen had met Gest at Oak Ridge during the war (Gest played the double bass "most proficiently," noted Kamen back then). Gest had received his bachelor's degree from the University of California, Los Angeles in 1942. During his undergraduate studies, he had spent two summers at the Cold Spring Harbor Laboratory assisting eventual Nobel laureates Max Delbrück and Salvador Luria with their research on bacterial viruses. Consequently, Gest began his graduate studies under Delbrück, then at Vanderbilt University, but World War II cut them short. During the war, Gest worked on the Manhattan Project under eminent physical chemist Charles D. Coryell. After the war, Gest applied to Kamen and was his first graduate student at Washington University. To learn about photosynthesis, Gest took the microbial physiology course given by Cornelius B. van Niel at the Hopkins Marine Station of Stanford University, located in Pacific Grove, California, on the Monterey Peninsula. Upon his return, he quickly convinced Kamen that the photosynthetic non-sulfur bacteria would be superior to algae as test objects, and thus they focused their research on photosynthesis and energy transduction in *Rhodospirillum rubrum*, the classic organism in this group of bacteria. This decision was a big step forward because biochemical analysis is much easier done with bacteria than with plants or algae. Physicist Kamen was becoming a biochemist.

Thinking of that transformation, Kamen recollected, "I began to pay my dues as a novice entering the arcane practice of enzymology." A classical preparation from rabbit muscle involved the following: "It began with clubbing a rabbit senseless, then proceeding with haste to decapitate, skin, and eviscerate the carcass, followed by dissection of the muscle and chemical isolation using precipitation with heavy metal salts. After several such episodes, I became convinced I would rather be a microbiologist." Indeed, the preparation of cell-free extracts was simpler and more reproducible with bacteria.

It was in St. Louis that Kamen met his second wife, Beka Doherty, "a handsome and willowy redhead." She was later a science and medicine correspondent at *Time* magazine. In 1947, Kamen was planning to go to a meeting at the Weizmann Institute in Israel. In New York just prior to his departure, his passport was confiscated and for seven more years he could not travel. Just one person in the State Department was responsible for rescinding Kamen's passport—Ruth B. Shipley, then chief of the Passport Division. She had the unreviewable authority to determine who could leave the United States, for how long, and under what conditions. If she determined that someone's travel was, in the language of her day, "not in the best interests of the United States," that U.S. citizen stayed put. Shipley had denied passports to singer and actor Paul Robeson, playwright Arthur Miller, and chemist and eventual Nobel laureate Linus Pauling. Martin Kamen was in good company.

In 1948, Kamen was subpoenaed to appear before the House Un-American Activities Committee, the now infamous HUAC. He had requested a public hearing but, in the end, consented to a private inquisition. It would have been very interesting to have been in that room. Kamen was much smarter than the politicians and was able to counter assertions made by the members of the committee.

> At one point the matter of leaks about Oak Ridge and Hanford as sites for the construction of the atom bomb arose. I was alleged to have been asked by the Russians about a news story they had read concerning the sudden appearance of a large community in Tennessee where research on nuclear energy was rumored to be proceeding. I

> attempted to supply some perspective by noting that there had been an even worse, documented security breach when a story appeared about Los Alamos at the end of 1944, written by a reporter for a Cleveland newspaper. Congressman McDowell entered the quiz at this juncture. "It is my belief as a member of the American Editorial Association that there was not one violation [of requests to eliminate references to Oak Ridge or Los Alamos] in several thousands of publications that were entrusted with that information during the war," he pompously asserted. I listened incredulously, as there had been innumerable instances of newspaper breaches of security, including the infamous revelations by the Chicago Tribune in its "exposé" of U.S. war plans in November 1941. McDowell was displaying a convenient lack of memory, or else deep ignorance of the facts.

A lot of other loyal scientists, including physicist J. Robert Oppenheimer, were subjected to the same sinister methods of that committee, as extensively portrayed, now seventy-five years later, in the epic biographical film *Oppenheimer* (2023). Many of the hearings were held in private and were shamelessly aggressive attempts to obtain confessions of leaks of technical information about the atomic bomb to Russian spies. Official reports of the committee hearings bore little resemblance to what actually occurred behind closed doors.

The hysteria about leaks of atomic secrets arose from a complete ignorance and suspicion of science that is still evident in many Americans today. The fact is that there was no single crucial atomic secret that could be leaked to the Russians. The only thing they needed to know was that it could be done. Full-scale efforts to build the atomic bomb in the United States only really got going in 1943, and two bombs were dropped on Japan two years later, ending World War II in the Pacific theater. That frightening accomplishment ushered the world into the atomic era, demonstrating that entire cities could be obliterated with a single bomb, yet it was also a remarkable technical feat. At the time, it was not at all certain that such a bomb could be built. That it could be is the only fact the Russians needed. There were very good physicists in Russia, but it took them four years to build a bomb. Hence, it does not appear to historians that espionage played any critical role in their eventual success, but whether Russian spies had managed to obtain a few facts cannot be ruled out.

The anti-Communist hysteria of that period was damaging to many people. In 1951, the *Chicago Tribune* published articles that named Kamen as a suspected spy for the Soviets: "Washington U. Scientist Linked in Atomic Leak" and "Martin D. Kamen Fired from Army Project at California U. After Talking to Reds." These stories further unjustly damaged his reputation. Soon after, Kamen attempted suicide. "One black night I reached bottom. In a suicidal fit, I made an abortive attempt to do away with myself. Beka discovered me lying on the bathroom floor, bleeding from numerous self-inflicted cuts on the face and throat." Luckily, it was a dull knife.

Kamen went on to sue the *Chicago Tribune* and the *Washington Times-Herald* for libel, winning his suit in 1955. Thus, it took Kamen nearly ten years to establish his innocence and prove that he had been wrongfully blacklisted as a security risk. He was also to regain his passport in 1955 in a three-month appeal to the Board of the Passport Division. The judge was an elderly and wise man, and it also helped that Shipley had retired and had been replaced by a more reasonable person.

In his autobiography, Kamen does not go into great detail about his subsequent career, and neither will this author. In 1957, he left Washington University and with Nathan O. Kaplan established a very successful graduate Department of Biochemistry at Brandeis University in Waltham, Massachusetts. In 1961, he joined Roger Revelle in creating the campus for the newly established University of California in San Diego (UCSD) in La Jolla. In 1968, I became an assistant professor in chemistry at UCSD, and Martin gave me part of his space. Assistant professors need a mentor, and he was mine. It was a wonderful and successful period for me, and I remain deeply thankful for his support.

Kamen's second wife Beka died in 1963, and his third, Virginia Swanson, died in 1987. After his retirement from UCSD in 1978, Kamen held an appointment in the Section of Molecular Biology in the Department of Biological Sciences and the Ahmanson Center for Biological Research at the University of Southern California, until his death in 2002 at the age of eighty-nine in Montecito. He is survived by his son David, a translator at the United Nations in New York City.

Note

My information for writing this article largely comes from the 2022 reprint of Kamen's 1985 autobiography, *Radiant Science, Dark Politics: A Memoir of the Nuclear Age* (Berkeley: University of California Press, 1985). See also UC's tribute by members of the faculty senate, "In Memorium, Martin David Kamen, Professor Emeritus of Chemistry, UC San Diego, 1913–2002": https://senate.universityofcalifornia.edu/ files /inmemoriam/html/MartinDavidKamen.html

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