NATIONAL ACADEMY OF SCIENCES

ELKAN ROGERS BLOUT
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A Biographical Memoir by

LUBERT STRYER

Biographical Memoir

Photo Courtesy of Gail Blout.

E. R. Blout

ELKAN ROGERS BLOUT

July 2, 1919–December 20, 2006

BY LUBERT STRYER

ELKAN BLOUT, A PIONEERING BIOPHYSICAL CHEMIST, had three distinguished, overlapping careers. First, he played a key role in developing instant photography at Polaroid. Concurrently, he initiated a research program on synthetic polypeptides that deepened our understanding of how the amino acid sequences of proteins specify their three-dimensional forms. Elkan subsequently focused on cyclic peptides as models of constrained conformation. In this third phase he also strengthened and enriched major scientific and biomedical institutions: Harvard Medical School, Harvard School of Public Health, National Academy of Sciences, and the Food and Drug Administration. He highly valued scientific friendship, collegiality, rational discourse, and entrepreneurship. In 1990 he received the National Medal of Science: "For his pioneering studies of protein conformation and devotion to the scientific enterprise of the Nation."

RACING THROUGH THE YOUNG YEARS

Elkan, an only child, was born in New York City on July 2, 1919. His father, Eugene, was a salesman in the lace industry and his mother, Lillian, was a real estate agent.[1] He was 10 when the Great Depression began in 1929. The family finances worsened in the ensuing years, which made Elkan aware that he needed to succeed on his own. His childhood was brief, for he was driven to excel and become independent early. Elkan skipped three grades in elementary school, which led to his graduating from high school at age 14. He was too young then to go to college. Somehow his extended family raised $1,000 to send him to Phillips Exeter Academy for a year, a wonderful learning and maturing experience for him. In particular, he was inspired by John Hogg, a chemistry instructor, to pursue chemistry rather than law. Elkan was always grateful to Exeter and was particularly moved when he received their John Phillips Award in 1998, which cited his "nobility of character and usefulness to humanity."

He chose to go to Princeton for his undergraduate years because it was a first-class institution near home, which would enable him to frequently visit his cancer-stricken mother. Lillian was diagnosed with breast cancer while he was at Exeter and died during his junior year of college. Elkan was one of a small number of Jews admitted to Princeton in 1935. He was not invited to join an eating club. Instead, he frequently had meals with his roommate, Jack Reiss. Not coincidentally, Elkan and Jack married sisters several years later. Though Elkan had a scholarship at Princeton, he needed to earn money to cover his expenses. His entrepreneurial bent was evident when he reinvigorated the Campus Sales Agency, which sold souvenirs and other gifts that undergraduates gave their friends and family. Remarkably, Elkan left Princeton with $2,000 more than he had when he entered.

Elkan displayed early in his career an interest in the interface between chemistry and biology, particularly medicine. His senior undergraduate thesis research was carried out in the laboratory of Greg Dougherty, a professor of organic chemistry. Elkan worked on the synthesis of sulfanilamide, the first clinically useful antibiotic, which had been discovered four years earlier. Elkan greatly appreciated the fine teaching he experienced at Princeton.

While walking his fox terrier on West 86th Street in Manhattan, Elkan met Joan Dreyfus, who likewise was walking her terrier. This chance encounter led to their courtship and then marriage soon after Elkan's graduation from Princeton in 1939, when Elkan was 20. While at Princeton, Elkan introduced Lorraine Dreyfus, Joan's sister, to Reiss, which led to their marriage a week after Elkan and Joan's, and a lifelong friendship of the brothers-in-law. Joan and Elkan had three children: James (born in 1943), Susan (born in 1945), and William (born in 1947). Elkan and Joan were separated in 1978 and divorced in 1984.

BECOMING AN ORGANIC CHEMIST

Elkan applied to Harvard and Columbia for graduate work in chemistry. Harvard turned him down, most likely because his grades as an undergraduate were not stellar (Elkan spent many hours playing poker), but Columbia took a chance and accepted him.[1] At Columbia, Elkan joined Robert Elderfield's laboratory because Elderfield had biological interests—he devoted many years to the study of cardioactive steroids, such as digitalis—and was a sympathetic and highly accomplished mentor. Elkan's thesis research dealt with the synthesis of simple model butenolides, which are analogs of cardiac aglycones (the steroid nucleus of a cardiac glycoside devoid of its carbohydrate moiety). Elkan devised a method for introducing a double bond by the elimination of an α-substituent of a β-substituted butyrolactone. The pace of Elkan's graduate study, like that of his earlier schooling, was swift: he received his Ph.D. degree in three years, at age 23. Elderfield regarded Elkan as highly promising and recommended him for a National Research Council Fellowship.

Elkan received this coveted award, of which only five were given in chemistry.

The doors of Harvard were now open to Elkan. He decided to go to Harvard in 1942 to work with R. Patrick Linstead, who led their organic chemistry program. But soon after Elkan arrived, Linstead headed back to his native England to help with the war effort. Elkan was redirected to Louis Fieser but soon found Robert Woodward, a young and very bright instructor. Elkan told Woodward about three ideas he had submitted as potential research topics and they soon began working together on one of them. They showed that the condensation of the sodium enolate of butyroin with ethyl acetate yields a 1,3-pentadione derivative, rather than a cyclopropene derivative, as had been proposed by another group. The ultraviolet absorption spectrum of the adduct was a key line of evidence supporting their structural assignment. Elkan learned the value of ultraviolet spectroscopy as a diagnostic tool in his senior year at Princeton. Their study opened a new and general route to what had previously been a quite inaccessible class of compounds. Elkan and Woodward also played poker together frequently and enjoyed each other's company. A deep and enduring friendship began.[2]

After exploring a number of career opportunities, Elkan decided to accept a position as a pharmaceutical chemist at Sharp & Dohme (which later became Merck, Sharp & Dohme) in Philadelphia and rented a house there. He and Joan packed their belongings and gave a going-away party a week before their planned departure from Cambridge. Woodward came late to the party and explained that Edwin Land kept him at Polaroid. Woodward was a consultant there because of Land's interest in quinine, a compound used to make sheet polarizers. When Land asked Woodward why he had to leave, he explained that he was invited to Elkan's going-away party.

Land's interest was immediately aroused and he said that he would like to talk to Elkan the following day.

The two got together the next afternoon. Land asked Elkan what interested him. When Elkan told Land that they were in the field of "light, matter, and their interactions," Land immediately became "animated" and offered Elkan a position at Polaroid with a significantly higher salary and more independence than he would have had in Philadelphia.[3] Elkan accepted on the spot and on returning home told Joan what had happened; they began unpacking that evening. That was the start of Elkan's very fulfilling 18 years at Polaroid. A chance event, followed by his instant rapport with a kindred spirit, changed the course of his life.

DEVELOPING INSTANT PHOTOGRAPHY

Starting in the 1930s Land envisioned using polarized headlights and oppositely polarized windshields (or driver's glasses) to block the glare of oncoming vehicles. When Elkan joined Polaroid in 1943, the focus was on developing heat-stable polarizers for auto headlights. Polaroid also designed and produced plastic optical components for the war effort. Elkan led the organic chemistry group, which initially consisted of himself and one other chemist but it grew rapidly. He enjoyed interacting with spectroscopists and engineers, and found the atmosphere at Polaroid challenging, stimulating, and satisfying from the start.

At the end of the war it was evident that the auto industry would not adopt polarized headlights and that Polaroid would need to find new potential products to survive. Elkan became interested in ultraviolet spectroscopy of tissues for diagnostic pathology, and Land thought of translating UV images into the visible to obtain color images. Polaroid received a large contract from the Office of Naval Research to build a color-translating UV microscope. The instrument was built but could not be commercialized because the images proved to be less informative than had been hoped.

As Elkan recounted,[3] Polaroid's salvation came from a question posed by Land's three-year-old daughter in 1944, when they were on vacation near Santa Fe: "Why can't I see this picture right away?" she asked, when her father took a photo of her. Her question triggered the development of instant photography: Land worked feverishly on the concept while on vacation. Two years later, Land and a small, totally dedicated group produced silver-image photographs but the method was not robust. Elkan and his chemical team were called upon to solve a number of practical problems and to help convert a "laboratory curiosity into a saleable product." Elkan's chemical group worked closely with highly talented colleagues such as William McCune, Otto Wolff, and Howard Rogers to make black-and-white (or sepia) instant photography a commercial reality. The first Polaroid camera went on sale at the end of 1948. Two years later Elkan was given the resources to hire more than 30 new chemists with the mandate of producing color photos within a minute, a daunting challenge he undertook with gusto.

In 1954 Polaroid, aided by a collaboration with Kodak, was able to produce three single-color images using dye developers. Elkan sensed that the principal challenge of instant color photography was solved and "did what I had never done before in my life at that point. I went out and borrowed twenty-five thousand dollars and invested it in Polaroid stock. It took eight years before color photography was a reality in the market, but I felt that we could do it at that time."[1] He also succeeded in getting stock options for himself and Polaroid's other officers. In 1960 instant color film became a commercial reality. "To the scientific parents of this brainchild, myself included, it was all very wonderful and beautiful."

More than 30 years later Elkan gave an appreciative and vivid account of Land:

> Knowing him was a unique experience. He was a true visionary; he saw things differently from other people, which is what led him to the idea of instant photography. He was a brilliant, driven man who did not spare himself and who enjoyed working with equally driven people. He possessed great powers of concentration. I have now come to believe that complete concentration is absolutely necessary for achievement. It is fine to be brilliant, it is good to work hard, but you must have real concentration in order to achieve in life. More than anything else, that is what I learned from Din Land.[3]

Polaroid's success in the late 1950s gave Elkan a deep sense of accomplishment, a high level of confidence, and financial independence. He decided in 1959 that the time was approaching for him to leave Polaroid and pursue new challenges.

EXPLORING NEW TERRAIN

The groundwork for Elkan's transition from Polaroid to the academic world occurred over more than a decade. In 1950 Elkan began a part-time association with the Children's Cancer Research Foundation at Children's Hospital, Boston, a Harvard-affiliated hospital. Sidney Farber, the director of the foundation, was a pathologist and leader in the treatment of childhood cancers. He was aware of Elkan's development of a color-translating UV microscope and recruited Elkan to open a spectroscopy laboratory at Children's with the expectation that the diagnosis of children's diseases would be advanced by the introduction of new methods. Elkan worked late afternoons and evenings there and began building a scientific life that was separate and distinct from the one at Polaroid but that would draw on his expertise in both synthetic organic chemistry and spectroscopy.

He chose to work on synthetic polypeptides as models of proteins, inspired by Linus Pauling's groundbreaking papers in 1951 proposing the α-helix and β-pleated sheets as major structural motifs.[4] Elkan's wide-ranging discussions with Woodward led to the idea of his making synthetic polypeptides by using N-carboxyanhydrides of amino acids as activated building blocks.[1] Who would support such a novel program? The answer came from a discussion Elkan had with Jacob Fine, a professor of surgery who was interested in the treatment of shock. When Fine heard that Elkan wanted to make high molecular weight synthetic polypeptides, he suggested that these compounds might be effective substitutes for plasma in expanding blood volume and that the Army might want to support their development. Elkan then applied to the Office of the Surgeon General of the Army, who indeed supported his research program on synthetic polypeptides for more than a decade.

In 1954 Elkan, Paul Doty (a professor of chemistry at Harvard), and their coworkers published two notes reporting the synthesis and characterization of high molecular weight poly-γ-benzyl-L-glutamate in solution. Polypeptides having molecular weights higher than 100,000 were obtained by polymerizing the highly purified N-carboxyanhydride of γ-benzyl-L-glutamate in dry dioxane using sodium methoxide as the initiator. Light scattering and intrinsic viscosity studies revealed that the synthetic polypeptide is α-helical in weakly interacting solvents such as chloroform. By contrast, the synthetic polypeptide behaved as a random coil in strongly interacting solvents such as dichloroacetic acid.

Elkan and his group at Children's then prepared high molecular weight poly-L-glutamic acid (PGA) by treating the γ-benzyl ester of the polypeptide with HBr under anhydrous conditions to avoid peptide bond hydrolysis. Infrared dichroism and optical rotatory studies showed that the polypeptide in aqueous solution is helical at low pH (less than about 4.5), where the side chain carboxyl groups are most un-ionized, and a random coil at pH values higher than about 6, where the carboxyls are mostly ionized. Elkan and Martin Idelson concluded in their 1958 paper that electrostatic repulsion of the negatively charged side chains of the polypeptides at high pH values drove the helix to random coil transition. This inference was supported by the finding several years later that poly-L-lysine in aqueous solution displayed a converse pH dependence produced by electrostatic repulsion at low pH but not at high pH. The magnitude of the optical rotatory change seen in the helix to coil transition of these synthetic polypeptides was comparable to that observed in many proteins on denaturation, which suggested that protein denaturation is typically accompanied by a loss of α-helical structure.

MENTORING

Soon after entering Harvard Medical School in 1957, I was eager to carry out part-time research along with my medical studies. I contacted Farber because I was given his name by a supporter of the Children’s Cancer Research Foundation. Farber saw me that afternoon and suggested that I talk to “an unusual scientist” that evening. I met Elkan a few hours later and was immediately captivated by his energy, drive, breadth, and vision. When he asked me what I wanted to do in research, I said that I was interested in the binding of dyes to proteins and in fluorescence energy transfer. He then told me about his research on synthetic polypeptides as models of proteins and took me around his laboratory, which was highly active at a late hour. At the end of the evening I was thrilled when Elkan offered me a research position that was the start of a wonderful half-century association and friendship that profoundly transformed and enriched my life.[5]

I learned from Elkan how to measure the wavelength dependence of optical rotation using a manual Rudolph spectropolarimeter. I began by monitoring the known helix-coil transitions of poly-L-glutamic acid and poly-L-lysine before turning to their complexes with dyes. One afternoon I found that the optical rotation of acriflavine bound to the helical form of poly-L-glutamic acid changed dramatically with wavelength in the vicinity of the visible absorption band of the bound dye. The helical polypeptide by itself showed only a monotonic change in optical rotation in this spectral region, and the dye alone was optically inactive. I presented these data to Elkan that evening and told him that I was puzzled by the large magnitude of the optical rotation of the dye: polypeptide complex and that it went positive and then negative in such a short-wavelength interval. Elkan's eyes lit up as he told me, "Ah, you've just seen a Cotton effect!" He then gave me an illuminating tutorial on how optical activity arises in the absorption bands of chiral molecules and is expressed as circular dichroism or circular birefringence. We were then excited to find that acriflavine bound to the random coil form of the polypeptide exhibited no Cotton effect in the visible. Woodward communicated to the *Proceedings of the National Academy of Sciences* our paper reporting that symmetric dyes could become optically active on binding to helical polypeptides.

Elkan was a superb mentor for me and many others who had the good fortune of working with him. He helped his students and postdoctoral fellows choose research problems that were both significant and experimentally accessible using the latest technologies, particularly spectroscopic methods. He gave them freedom to explore but always was available when guidance was needed. Elkan highly valued clear exposition, both in the writing of papers and in the presentation of research talks. He also cared deeply about the future careers of his students and fellows, and spent much time and effort in placing them in laboratories that would further their growth.

The scientists in his laboratory benefited in yet another way. Elkan had a remarkable circle of scientific friends around the world. Some of them spent weeks or months with Elkan. We had the good fortune of being introduced to outstanding scientists such as Ephraim Katchalski-Katzir (from the Weizmann Institute in Israel), Jean-Marie Lehn (from the Collège de France), Nelson Leonard (from the University of Illinois), G. N. Ramachandran (from the University of Madras), and Yuri Ovchinnikov (from the Shemyakin Institute in Moscow). Elkan's international outlook greatly enhanced our laboratory experience.

DISCOVERING KEY RULES

Elkan's research at Children's Hospital in the 1950s was centered on a fundamental question: What is the relationship between the amino acid sequence of proteins and their three-dimensional structures? In 1960 Elkan, together with Christiane de Lozé, Stan Bloom, and Gerry Fasman, published an incisive and seminal paper entitled "The Dependence of the Conformations of Synthetic Polypeptides on Amino Acid Composition" that was the harvest of a highly productive decade of research on synthetic polypeptides. They discovered, using optical rotatory dispersion and infrared spectroscopy, that some amino acids lead to an α-helix, whereas others give rise to a β-pleated sheet or random coil, and explained why. Amino acids that are disubstituted with other than hydrogen on their β-carbon, such as valine, were proposed to be nonhelix formers because of steric hindrance imposed by bulky substituents on their β-carbon atom. Cysteine and serine were nonhelix formers for a different reason: the presence of a heteroatom (O or S) linked to the β-carbon was thought to interfere with intrachain hydrogen bonding needed for α-helix formation. They concluded, “It seems probable that the effects described here on the relationship between amino acid composition and polypeptide structure also are operative in protein structures. When a sequence of β or random-forming amino acids is contiguous to an α-helical section of a protein chain this may be a site where a loop or reversal of direction can occur.” Their conclusion was right on the mark, a breakthrough in understanding how the alphabet of 20 amino acids is used to shape protein architecture.

PROBING PROTEIN CHIRALITY

Elkan’s laboratory also pioneered in making spectroscopic expressions of optical activity a revealing window on protein conformation. In 1961 he and his coworkers extended their optical rotatory measurements further into the ultraviolet and were rewarded by finding an intrinsic Cotton effect centered at 225 nm that was characteristic of α-helices. One of the collaborators in this study was Norman Simmons, a professor at the University of California, Los Angeles, who frequently spent several months in Elkan’s laboratory. Carolyn Cohen, who directed her own laboratory at Children’s Hospital, focused on muscle contraction, collaborated too, and enriched the study by contributing helix-rich contractile proteins and her insights into their conformational properties. This intrinsic Cotton effect, arising from a weak n-π* amide transition in a helical environment, proved to be very useful as an empirical measure of the α-helix content of proteins. A year later a larger Cotton effect centered at 190 nm arising from the strong π-π* amide transition was found for α-helices, compared with a small Cotton effect of opposite sign for random coils. Elkan and coworkers subsequently identified the ultraviolet conformation-dependent Cotton effects arising from the poly-L-proline I and II helices and the collagen triple helix, which brought his spectroscopic studies of protein main-chain chirality to a satisfying close.

CHARTING CONFORMATIONAL SPACE

The year 1962 was a turning point in Elkan's life. His years at Polaroid came to fruition with the successful development of instant color photography and its worldwide use by millions. Elkan felt there was no major challenge ahead at Polaroid and decided to become a full-time professor because he found "the academic world intellectually exciting."[1] He was offered professorships at three institutions: his alma mater, Columbia; Massachusetts Institute of Technology; and Harvard Medical School. He accepted Harvard's offer and became the Edward S. Harkness Professor of Biological Chemistry. Elkan retained his ties with Polaroid for many years by serving as a scientific adviser.

Elkan greatly enjoyed his new life as a Harvard professor. The move from Children's Hospital to the medical school quadrangle gave Elkan the scope and time to pursue new lines of research. His studies of linear polypeptides containing glycine and proline led to a major research program on cyclic peptides, which appealed to Elkan because they are conformationally constrained and therefore more amenable than are linear peptides to experimental and predictive analyses. He was particularly interested in cyclic peptides containing proline and glycine because they served as models of turns in proteins, where the main chain reverses direction. Over more than two decades Elkan and his coworkers used ^{13}C nuclear magnetic resonance, conformational energy calculations, and circular dichroism to delineate the conformation of these cyclic peptides and gain insight into the rules governing the folding of turn regions. They also gained a deeper understanding of the ion-binding properties of these cyclic peptides. Elkan's talented coworkers in these broad-ranging studies included Charles Deber, Lila Gierasch, Vincent Madison, and Dennis Torchia.[6]

Elkan's laboratory in these years also explored many facets of protein structure and function, as exemplified by studies of the binding and catalytic mechanisms of serine proteases such as elastase and chymotrypsin, the activation mechanism of prothrombin in clotting, and the folding of myoglobin. William Veatch, Eric Fossel, and Bonnie Wallace carried out a series of highly informative studies of gramicidin A, a 15-residue bacterial peptide that forms transmembrane ion channels when it dimerizes. Another noteworthy accomplishment of this phase of Elkan's research career was the first synthesis of model compounds in which a fluorescent energy donor was separated from an energy acceptor by a defined distance. Samuel Latt, H. T. Cheung, and Elkan found that the transfer efficiencies observed in these bis-steroid compounds were in good agreement with the values predicted by Förster's theory.

Elkan was nearly totally immersed in research but he did relax at Cuttyhunk, an island 12 miles south of New Bedford, a preeminent whaling port of the 19th century. He especially enjoyed boating his *Nomad*, a converted lobster-fishing vessel, and then the *Peptide*. Elkan was a skilled and avid saltwater fisherman at Cuttyhunk and Key Biscayne but he never managed to land a swordfish with rod and reel, perhaps his most coveted unfulfilled goal.

FURTHERING THE SCIENTIFIC ENTERPRISE

After Elkan came on board as a professor at Harvard Medical School, George Packer Berry, the dean, lost no time in offering him the chair of the Department of Biological Chemistry. Elkan's scientific and organizational leadership capabilities, evidenced by what he did at Polaroid, were well known to the community. He appreciated the offer but asked for a bit of time to set up his laboratory and familiarize himself with his new academic environment. Berry agreed, and in 1965 Elkan became chair of his department. He recruited many fine young scientists and developed a collegial spirit that enabled the department to prosper. Elkan was likewise appreciated by two successor deans, Robert Ebert and Daniel Tosteson, who often called on him for advice on the basic sciences generally. For example, Elkan chaired the ad hoc committees that appointed all tenured professors at the medical school.

In 1978 Howard Hiatt, dean of Harvard's School of Public Health, urged Elkan to play a major leadership role in the school by becoming dean for academic affairs. Elkan enthusiastically accepted and did much to give the school a focus (global health) and a strong scientific underpinning. The spirit of the institution also became more harmonious during Elkan's successful 10-year tenure as academic dean.

Soon after Elkan's election to the National Academy of Sciences in 1969, he became active in the financial affairs of the Academy by serving on its finance committee. Elkan's advice was sought because he had a strong command of finances as a result of his years at Polaroid, where he had served on the corporation's executive committee while also directing its chemical research, and had a reputation for prudence. In 1980 Elkan was elected treasurer of the Academy and held the position for 12 years, the maximum term possible. Much of the annual budget of the Academy comes from contracts with the federal government for specifically requested studies in its chartered role as the nation's scientific adviser. Elkan embarked on a major campaign to increase the endowment of the Academy so that it would have more independence and be able to carry out studies on its own initiative and pursue other activities (e.g., education) of its own choosing. In his years as treasurer the endowment increased from about $25 million to $125 million. About half of the fivefold increase came from gifts and the other half from capital appreciation. Elkan enjoyed serving with Frank Press, president of the Academy, and the other officers and looked back at his leadership years there with much satisfaction and warmth.[1]

In 1991 David Kessler, then recently appointed commissioner of the Food and Drug Administration, urged Elkan to join the agency as a senior adviser for science. Elkan accepted this challenge because it provided an opportunity to improve public health by strengthening the scientific base of the FDA. Kessler then said that with Elkan's appointment the agency was "for the first time forging—in a systematic way—links with the academic community to assure ourselves that we are communicating with those working at the cutting edge of science." In his five years as senior adviser Elkan brought in academic experts and promoted cooperation among the FDA scientists by setting up internal forums for discussion of scientific and policy matters.

Elkan furthered the scientific enterprise globally in many additional ways. He was a founder of the journal *Biopolymers*, a trustee of the Boston Biomedical Institute, a member of the Board of Governors of the Weizmann Institute of Science, an overseer of the Museum of Science in Boston, chair of the Advisory Council of Princeton's Department of Molecular Biology, and treasurer of the American Academy of Arts and Sciences.

Elkan received many honors and was held in high regard by the international scientific community.[7] He was elected to the National Academy of Sciences, Institute of Medicine, American Academy of Arts and Sciences, and the Russian Academy of Sciences. He received the Ralph F. Hirschmann Award in Peptide Chemistry from the American Chemical Society, the John Phillips Award from Phillips Exeter Academy, the Class of 1939 Achievement Award from Princeton University, and an honorary doctor of science degree from Loyola University. In 1990 he received the National Medal of Science: “For his pioneering studies of protein conformation and devotion to the scientific enterprise of the Nation,” a citation so encompassing and so apt.

CODA

Elkan married Gail Ferris in 1984. Nine years later they adopted a daughter, Darya, when she was a six-month old orphan in Kazakhstan. Elkan often spoke joyfully of Darya and also of his grandchildren, who frequently visited Elkan and Gail’s home in Marion, about an hour’s drive from Cambridge. They also built a home in Cuttyhunk for longer sojourns away from Cambridge in later years.

Elkan had a strong sense of place. He was fond of Cambridge and took daily pleasure in seeing the Charles River and the skyline of Boston from his home on Memorial Drive. He enjoyed meeting friends and taking guests to St. Botolph’s Club, a venerable landmark on Commonwealth Avenue in Boston’s Back Bay. He was attached to the sea and especially to Cuttyhunk.

Starting in his teens, Elkan developed lifelong friendships that were an integral part of his life. He kept in close touch with his international circle of friends over many years. Elkan was always engaged and helping when his friends or his scientific family were struck by adversity. He had a generous and optimistic spirit that was tempered by a sense of the world as it is.

Elkan cherished three institutions—Polaroid, Harvard, and the National Academy of Sciences—and worked for decades to strengthen them. He was always a voice of reason, civility, and wisdom. Elkan believed deeply in the power of institutions that had a strong sense of purpose. He had an abiding faith in the capacity of people to come together under inspired leadership to further science and enrich life.

NOTES

1. A wealth of information about Elkan's life can be found in *Elkan R. Blout, interviews by James J. Bohning and Arnold Thackray at Harvard Medical School, Harvard School of Public Health, and Cambridge, Massachusetts, 30 May 1991, 13 September 2002, and 22 November 2002.* Philadelphia: Chemical Heritage Foundation, Oral History Transcript no. 0263.
2. Elkan's admiration of Woodward's creativity and genius was expressed in his memoir of him in Blout, E. R., *Biographical Memoirs*, vol. 80, pp. 1-23. Washington, D.C.: National Academy Press, 2001.
3. E. R. Blout, ed., *The Power of Boldness: Ten Master Builders of American Industry Tell Their Success Stories*, pp. 61-75. Washington, D.C. Joseph Henry Press, 1996.
4. L. Pauling, R. B. Corey, and H. R. Branson. The structure of proteins: Two hydrogen-bonded helical configurations of the polypeptide chain. *Proc. Natl. Acad. Sci. U. S. A.* 37(1951):205-211; L. Pauling and R. B. Corey. The pleated sheet, a new layer configuration of polypeptide chains. *Proc. Natl. Acad. Sci. U. S. A.* 37(1951):251-256.
5. I presented "A Remembrance of Elkan R. Blout" at the memorial service for Elkan on January 26, 2007, at Harvard Memorial Church. L. Stryer. *Biopolymers* 89(2008):334-335; the same issue of *Biopolymers*, dedicated to Elkan's memory, contains additional remembrances and scientific papers by his former students, fellows, and colleagues.
6. Elkan provided informative synopses of his cyclic peptide research program in two reviews: C. M. Deber, V. Madison, and E. R. Blout. *Acc. Chem. Res* 9(1976):106-113 and E. R. Blout. *Biopolymers* 20(1981):1901-1912.

7. A touching tribute to Elkan was given by Ephraim Katchalski in "A Few Words of Appreciation to Elkan R. Blout: A Good Friend and a Distinguished Scientist." *Biopolymers* 24(1985):3-7; the same issue of *Biopolymers* contains papers presented at a symposium celebrating Elkan's 65th birthday.

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