

Correction

RETROSPECTIVE. For the article “The nine lives of Daniel E. Koshland, Jr. (1920–2007),” by Randy Schekman, which appeared in issue 37, September 11, 2007, of *Proc Natl Acad Sci USA* (104:14551–14552; first published August 24, 2007; 10.1073/pnas.0707644104), the author notes the following: “I credited Dan with construction of a machine to track bacterial movement in three dimensions, leading to the discovery that cells respond to chemical gradients ‘through a series of biased swimming motions consisting of “swims” and “twiddles.”’ The tracking was done by Howard Berg and Doug Brown, then at the University of Colorado in Boulder (1). The seminal achievement of Dan and Bob Macnab (2) was to show, by experiments in which chemical attractants were suddenly added or removed, ‘that chemotactic bacteria sense gradients in time, not in space.’”

1. Berg HC, Brown DA (1972) *Nature* 239:500–504.
2. Macnab RM, Koshland DE, Jr (1972) *Proc Natl Acad Sci USA* 69:2509–2512.

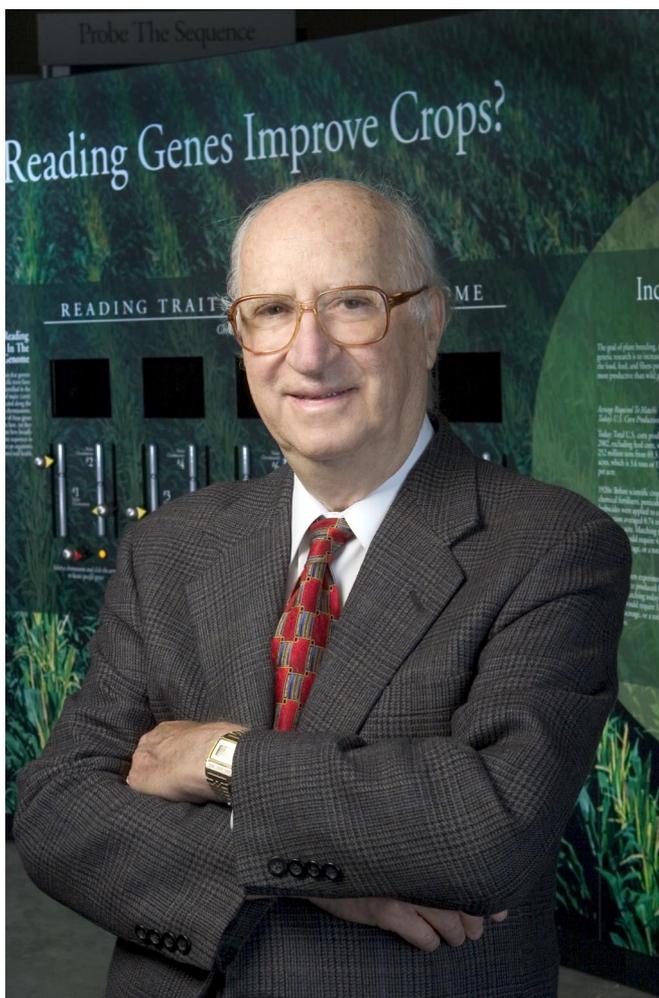
www.pnas.org/cgi/doi/10.1073/pnas.0709171104

The nine lives of Daniel E. Koshland, Jr. (1920–2007)

The scientific world lost a friend and pioneer with the passing of Dan Koshland on July 23rd of this year. Dan's singular contributions have left an indelible mark on those who had the pleasure of his company. In rough chronological order, he started as an inorganic chemist, then became an organic chemist, a biochemist, a professor, a department chair, the Editor-in-Chief of PNAS and then of *Science*, the czar of life sciences at the University of California, Berkeley, and in the last 10 years of his life, a benefactor and elder statesman. His model of science and service has inspired generations of young scholars.

Dan trained in inorganic chemistry as an undergraduate with Wendell Latimer at U.C. Berkeley and spent the war years in Chicago working on plutonium enrichment under the guidance of Glenn Seaborg for the Manhattan Project. A nascent interest in biology and Ph.D. studies with an inspiring young organic chemist, Frank Westheimer, tempted Dan away from inorganic and nuclear chemistry and into a lifelong passion for enzyme reaction mechanisms. Further training at Harvard University (Cambridge, MA) and a brief stint in Fritz Lipmann's laboratory led to Dan's first independent position at Brookhaven National Laboratory (Long Island, NY). During his work on the stereochemical specificity of enzyme reactions, Dan developed a deeper understanding of how an enzyme may adapt to a substrate, which led to his brilliant formulation of the induced-fit model of protein–ligand interaction.

In 1966, Dan and his wife, Marian (Bunny), a distinguished immunologist, and their five children returned to Berkeley, the scene of Dan's scientific awakening, where he took a faculty position in the Biochemistry Department. Dan continued his passion for enzymes in a department that focused on classical enzymology, with such luminaries as Horace Barker and Esmond Snell. Perhaps because of his move west or the mood of change in Berkeley, Dan grew interested in bacterial chemotaxis, a field that had been introduced into modern bacterial genetics through the pioneering efforts of Julius Adler at the University of Wisconsin (Madison, WI). This work carried Dan's effort into genetics, bacterial physiology, and, of course, biochemistry, for the next 20 years. Perhaps his crowning achievement was the construction of a machine to track bacterial movement in three dimensions. With this device, he, Rick



Daniel E. Koshland, Jr.

Dahlquist, and Bob McNab showed that chemotactic bacteria sense gradients in time, not in space, through a series of biased swimming motions consisting of “swims” and “twiddles.”

But Dan, the man, was more than just his science. The scion of a prominent San Francisco family with deep roots in the community and the University of California, Dan was imprinted with the responsibility gene. For Dan, this commitment included his children, his colleagues, his university, and his nation. He served as president of the school board when his children were in the public school system in Long Island, NY. Upon returning to Berkeley, he became chair of the Berkeley Biochemistry Department, and in 1975, he took pity on me, a green refugee from Stanford University, and took me in (but never failed to remind me of the profound disadvantage of my Ph.D. training at Stanford). Two years later, he welcomed back his star undergraduate,

Robert Tjian (Tij), who accepted a faculty position at Berkeley. Dan took Tij and me under his wing and guided us along the path from independent scientists to responsible academic colleagues.

As an editor, Dan brought his good humor to a task that requires diplomacy and thick skin. At PNAS (Editor-in-Chief, 1980–1984), Dan was one of the first editors to impose external standards on the publication of Academy members' contributed papers. Few aside from Dan would have dared face down Linus Pauling and some of his questionable views on the efficacy of megadoses of vitamin C. In 1985, at age 65, Dan took the position of Editor-in-Chief of *Science* (from 1985 to 1995), a job that had previously been considered full-time but which Dan handled part-time along with his research and a leadership role in the reorganization of life science de-

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partments at Berkeley. Before Dan, *Science* had a respectable but conservative portfolio and was not considered the most appealing venue for top-flight original research reports. With his broad network of colleagues in the physical and life sciences and his keen insights about people, Dan rebuilt *Science* with an independent staff of in-house editors and expert external board members. During his 10-year term, the impact factor of *Science* more than doubled, bringing it on par with *Nature* and *Cell*.

For those of us who had the gift of knowing Dan Koshland as a colleague, these were heady years with a mandate for change on the Berkeley campus. A supportive Chancellor, Mike Heyman, and Provost, Rod Park, afforded Dan the opportunity to shake things up with a reorganization of the life sciences. Using his considerable political skills and wide network of influence, Dan assembled an expert external advisory panel, prompted them to issue a dramatic call for a new vision of life science, and stood back to catch and rearrange the pieces that fell when the Chancellor distributed the advisory report to the

Berkeley life science community. Over a period of two years through several iterations, Dan forged a new alignment of disciplines, dispensing with 16 different life science departments crafted into three large units in two different colleges: Molecular and Cell Biology (MCB), Integrative Biology (IB), and Plant and Microbial Biology (PMB). The arrangement may seem obvious in hindsight, but the opposition, spearheaded by the chairs of the 16 departments that were disbanded, was visceral. Fortunately, Dan had the escape of a monthly trip to *Science* in Washington, DC. It was no accident that copies of his periodic reorganization reports were distributed to the faculty mailboxes on Friday afternoons just as Dan was jetting east.

The legacy of just this contribution alone would satisfy most, but in the past 10 years, Dan's generosity has blossomed with major gifts to the institutions he loved. He and Bunny endowed a science center at Haverford College, the alma mater of his sons and a future daughter-in-law; he established the Marian Koshland Science Museum of the

National Academy of Sciences in Washington, DC, in honor of his wife; he generously donated to the Weizmann Institute; and, in many ways large and small, he built a Koshland legacy on the Berkeley campus that rivals the great founders and benefactors of this institution in the 19th and 20th centuries.

After Bunny's death in 1997, Dan renewed an acquaintance with a woman he had briefly dated as an undergraduate at U.C. Berkeley. He and Yvonne were then married in a small ceremony at their home in Lafayette, CA. Remarking on the brevity of their vows, Yvonne said she and Dan had agreed to skip the part about obeying each other. That quip made it clear why she and Dan, and Dan and Bunny before, were such good matches.

It feels somehow empty to return to the building, Barker Hall, where Dan spent most of his 40-plus-year career at Berkeley. But the talented Koshland family and Dan's legacy live on in our hearts and in this the great institution of American science.

Randy Schekman, *Editor-in-Chief*