

Beatrice A. Singer: In Memoriam (1923–2005)

James E. Cleaver,¹ Priscilla K. Cooper,³ Stuart M. Linn,² and Mina J. Bissell³

¹University of California, San Francisco, San Francisco, California; ²University of California, Berkeley; and ³Lawrence Berkeley National Laboratory, Berkeley, California

Dr. Beatrice A. (Bea) Singer died July 20, 2005, after an outstanding career during which she applied her love of high-resolution chemistry to a wide range of topics. She made major contributions to the characterization of tobacco mosaic virus (TMV), RNA and DNA chemistry, alkylation, and other carcinogenic modifications of DNA, DNA repair, transcription, and replication fidelity.

She and her husband, Dr. Heinz Fraenkel-Conrat, had careers that spanned the pregenomic era to the present. Their work began at a time when the chemical nature of genetic material was controversial and to identify it was a major undertaking. They played a major role in demonstrating that RNA was the genetic material of TMV.

Dr. Singer's early research, in collaboration with her husband, concentrated on TMV and the characterization of its protein and, more importantly, its RNA components. Their studies from the 1950s and 1960s were among the early characterizations of RNA stability, structure, cation interactions, and nuclease susceptibilities.

As their research moved into the 1970s, Dr. Singer began to investigate the reactivity of TMV RNA with genotoxic agents, including photoreactive dyes and alkylating agents. These investigations also began to include DNA and set the stage for Dr. Singer's independent work on DNA alkylation and carcinogenesis that began in the late 1970s and that showed her talent not only as an analytical and synthetic chemist but also as an enzymologist and expert on the molecular basis of mutagenesis and carcinogenesis.

Dr. Singer was influential in identifying the many DNA alkylations that we now take for granted and she established their role as substrates for glycosylases in base excision repair. She later extended her studies to vinyl chloride and other chemical carcinogens. In recent years, her research showed the capacity of the many newly discovered mammalian DNA polymerases to replicate alkylated bases.

Dr. Singer knew many experts in the field and was one of them herself. She was an exceptional individual, determined that she should be judged on her own merit. For many years, she eschewed honors that were well deserved, for fear of being regarded as "...the wife of..." rather than herself. Even so, she was recognized by the AACR with their Special Award in Recognition of Leadership and Contributions to Cancer Research in 1992 and by the Environmental Mutagen Society with their Alexander Hollaender Award in 2003.

Dr. Singer spent her entire professional career at the University of California, Berkeley. She began as a research associate from 1946



to 1964, worked as an associate research biochemist in the Virus Laboratory of the Department of Molecular Biology from 1964 to 1970, and later served as a Professor in the Department of Molecular Biology and Space Sciences Laboratory from 1970 to 1985.

She became an Emeritus Professor in 1985 and continued working in the Department of Molecular Biology and Space Sciences Laboratory, and Lawrence Berkeley Laboratory, Life Sciences Division. During this long and extensive career, Dr. Singer was a visiting scientist in a wide range of places, including Paris (1966), Strasburg (1974), Bellagio (1981), Australia (1982), and Warsaw (1986).

Dr. Singer also served the City of Berkeley by chairing their Charter Review Commission, the Merit Commission of the Berkeley School Board, and a Study on Administration of Justice. At one time, she led the Berkeley League of Women Voters, and during the 1970s she was an assistant to the vice chancellor at the University of California, Berkeley, and advised on the needs of academic women.

Dr. Singer played a formative role in developing the West Coast Gordon Conference on Mammalian DNA Repair that meets in southern California in early winter on alternate years. She chaired this conference in 1986 and was also the chair of the 1982 Gordon Conference on Mutagenesis. I (James E. Cleaver) was privileged to chair the West Coast Gordon Conference in 1993 under her watchful eye where she assessed me critically on the science ("okay, but too much about genes"), the beer ("acceptable," a concession to my British heritage), and the wine ("leaves something to be desired!").

As an emeritus professor, a time when others slow their pace, there was no let-up in Dr. Singer's activities. During this period, she served on the Scientific Advisory Board of the National Center

Requests for reprints: James E. Cleaver, University of California School of Medicine, 2340 Sutter Street, Room N424, Box 0808, San Francisco, CA 94143-0808. Phone: 415-476-4563; Fax: 415-476-8216; E-mail: jcleaver@cc.ucsf.edu.
©2006 American Association for Cancer Research.
doi:10.1158/0008-5472.CAN-06-0033

for Toxicological Research, the Chemical Pathology Study Section of the NIH, the Board of Scientific Counselors of the National Institute of Environmental Health Sciences, and the Advisory Board of the City of Hope (Duarte, CA). She served on numerous editorial boards, including *Cancer Research*, *Molecular Toxicology*, *Carcinogenesis*, *Chemical Research in Toxicology*, and the *International Journal of Oncology*. She also edited several important publications in chemical carcinogenesis, including *Molecular Biology of Mutagens & Carcinogens* (with Dezider Grunberger), *The Role of Cyclic Adducts in Carcinogenesis and Mutagenesis*, *IARC Scientific Publications* vols. 70 and 150, and *Exocyclic DNA Adducts in Mutagenesis and Carcinogenesis*. Several of these works were issued from conferences that she helped organize and chair.

Dr. Singer continued to win competitive grants despite battling a series of illnesses. Her final grants included studies on the biochemical mechanism of exocyclic adducts in cancer

and human glycosylase repair of cyclic adducts. She epitomized the character of many senior scientists, who, having had a full career, still have much to give, full of insights and experience. Retirement was never in her vocabulary. I (James E. Cleaver) had the temerity to ask her about her health earlier in 2005, only to be told in no uncertain terms, "My health is fine. I only have an injury!" She was a competitive scientist and individual but was very supportive to those prepared to work as hard and as thoughtfully as she.

Dr. Singer was a remarkable scientist. She led a long and productive career that affected many of our lives and left an indelible imprint on the field of chemical carcinogenesis and DNA repair. She could be combative, aggressive, even aggravating, but had impeccable standards and was always determined that, above all, one's science should be first rate. Many of us owe her a great deal, and the field has lost one of its stellar pioneers.