

Frank N. Low: Gentle Giant of Electron Microscopy (1911–1998)

Dr. Frank N. Low is described variously by his colleagues, friends, and students as a pioneer in electron microscopy, a teacher's teacher in the anatomical sciences, or an inspired genius of morphological interpretation. But all agree that this soft-spoken, kind man was a true gentleman in the best sense of the word. Though he published more than 100 full-length articles and was funded nearly continuously throughout his research career by such agencies as the Office of Research and Development, the Civil Aeronautics Administration, the Office of Naval Research, and most extensively by the National Institutes of Health, he remained an approachable educator who was genuinely courteous to all. He was a gifted and charismatic mentor who taught through example that the quest for scientific knowledge and truth need not exclude respect for and appreciation of art, history, other cultures, and particularly fellow human beings.

Frank Low was born in Brooklyn, New York in 1911, where he attended Erasmus Hall High School and then went on to receive his undergraduate degree from Cornell University in Ithaca, New York in 1932. He attended medical school at the University of Buffalo immediately after graduation but returned to Cornell University where he studied with Benjamin F. Kingsbury and completed his Ph.D. in Histology and Embryology in 1936.

Following graduation, Low accepted a position as Charlton Fellow at Tufts College Medical School in Boston and began a long and productive career in teaching and research. He held positions at the University of North Carolina, the University of Maryland, the University of West Virginia, and the Johns Hopkins University School of Medicine before beginning a 15-year tenure at Louisiana State University



Frank N. Low, Ph.D. Photograph kindly provided by the Office of University Relations, the University of North Dakota.

(LSU) Medical Center in New Orleans. In 1964, Low was appointed Hill Research Professor at the University of North Dakota (UND) School of Medicine in Grand Forks, a position he held until his formal retirement in 1981.

Frank Low's research career began with a series of highly respected studies on peripheral visual acuity published in *Science* and in the *American Journal of Physiology* (1943–1947). However, his fascination with new technology brought an insatiable desire to enter the developing field of transmission electron microscopy, and in 1953, he established the first electron microscopic facility at LSU Medical Center. Using this instrument, Low became internationally known for the superb quality of his micrographs. In a seminal manuscript, he published a TEM description of the pulmonary epithelium in rats, which showed for

the first time, that the blood-air barrier in mammals was not syncytial, and that all alveoli were lined by a continuous pulmonary epithelium subtended by a basal lamina.¹

Subsequently, Low published a series of papers on tissue preparation for electron microscopy, and then joined forces with one of his medical students to produce what has become a classic text on the ultrastructure of blood cells.³ This was followed by his often-cited study in which he defined the microfibril as a bona fide component of the extracellular matrix.² His increasing recognition as an expert in TEM spawned the beginning of an illustrious career in graduate training and his first student, William Winborn, finished his Ph.D. in 1963.

Frank Low's academic career took a major turn in 1964 when he accepted a position as Hill Research Professor of Anatomy at UND, where he immediately developed an electron microscopic laboratory that was state-of-the-art. He teamed with Dr. Christopher J. Hamre—then chairman of the UND Anatomy Department—to parlay a large cadre of eager, bright, graduate students, freshly recruited to a well-established training grant, into investigations involving electron microscopic research. It was then that his family of graduate students truly began to grow. In his subsequent 17 years at UND, he trained 23 Masters and 19 Ph.D. students, many of whom have developed distinguished careers in teaching and research. I can speak from personal experience that the opportunity for a graduate student to work with this gentle giant of ultrastructure was nothing short of inspirational.

Dr. Low taught us everything. He first introduced us to the classical literature of light and electron microscopy. Then he explained the concept of the scientific method. He showed us

how to design and carry out credible research projects. He worked tirelessly with his students, painstakingly offering hands-on help with technical details. He taught us the concepts of organization, repetition, and explainability. He tutored us individually in foreign languages. He showed, by example, how to turn a phrase and how to write clearly and concisely. He met with us one-on-one, demonstrating the elements of a strong platform presentation. We were honored to be in his presence. We, indeed, became his family.

Low's curiosity for new technology was never satiated. In the early 1970s he branched into scanning electron microscopy and successfully competed for grant funds from the NIH to develop the first SEM facility in the State of North Dakota. Likewise, he became interested in freeze-fracture technology and quickly secured the funds for freeze-etch and freeze-fracture devices. Low's students adopted these techniques and unhesitatingly incorporated them into their thesis and dissertation investigations. During his 17 years at UND, the Low laboratory churned out nearly 60 full-length papers and an equal number of abstracts. These included light and electron microscopic analyses of connective tissue histogenesis in the early chick embryo, surface morphology of gastrointestinal and cardiovascular tissues, and the substructural details of peripheral nerve and leptomeninges in the rat.

Dr. Low willingly worked with, or participated in, organizations he believed facilitated basic science research. In the early 1950s he helped to establish the Louisiana Society for Electron Microscopy, and in 1960, he became one of the charter members of the American Society for Cell Biology. He was a long-time Associate Editor for the *American Journal of Anatomy* (now *Developmental Dynamics*), served 4 years on the Executive Committee of the American Association of Anatomists, and was an active member of that society for more than 50 years. He

strongly supported the Electron Microscopic Society of America, and worked closely with Dr. Om Johari and the Scanning Electron Microscopy Symposia. Moreover, he was active in the People to People program and traveled extensively with the group to many parts of the world, often presenting his work.

Dr. Low was awarded a Chester Fritz Distinguished Professorship from the University of North Dakota in 1975 to 1977 and upon his formal retirement in 1981, the school honored his research accomplishments by designating an annual Dr. Frank N. Low Research Day to bring together faculty and student researchers in basic and clinical medicine to present summaries of their current work. In 1983, he was awarded an honorary Doctor of Science degree from UND, and in 1989, he received the highest award given by the American Association of Anatomists, the Henry Gray Award. In 1996, Dr. Low was honored once again by his friends and colleagues at UND when they dedicated the new Frank N. Low Conference Room to him and his legacy at that school.

At his retirement from UND, Low was appointed Professor Emeritus. However, he decided to return to New Orleans and to LSU Medical Center where he was appointed Visiting Professor of Anatomy by his long-time friend and colleague, Dr. Marilyn Zimny, chairperson of the Anatomy Department. Not surprisingly, Low did not disengage himself from academia, but stayed absolutely in character and as Dr. Zimny reports, it was only a matter of months until he had a new NIH grant and had established a research program in the department.

At the LSU Medical Center, Low was anything but retired, and subsequently this remarkable scientist went right on training students and faculty in techniques related to the study of experimental ultrastructure. He developed a funded proposal for a new SEM for the LSU Anatomy Department and later garnered the cover article in *The Anatomical Record* when he published

an SEM investigation on the primary endoderm of the early chick embryo.⁴

Frank Low was a true scholar. He was well read, not only in science, but also in the arts. His stories held a special attraction for the listener, and his quick wit and shy sense of humor was very winsome. Dr. Zimny says, I loved to listen to his stories. I learned more from him about a multitude of topics than any set of books could tell.

Thankfully, Frank Low had his sharp mental faculties until the day he died on April 28, 1998. He was a brilliant and kind man, blessed with the ability to generate enthusiasm for learning and zest for life. I will always be grateful for the times I was able to be with him and to be taught by him. I share the sentiments of his friends, but especially his students who collectively have said, Frank Low was first and foremost a teacher whose most outstanding attribute was his ability to train his students patiently and meticulously by advising and befriending them, guiding their maturation into competent scientists. Being remembered in this way would please Frank.

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