



Elizabeth Dexter Hay



Elizabeth (Betty) Dexter Hay, the first Louise Foote Pfeiffer Professor of Embryology at Harvard Medical School, and the first woman to lead a preclinical department at the medical school, passed away on August 20, 2007. She was 80 years old, leaving behind a rich legacy as a cell, extracellular matrix and developmental biology anatomist, and a beloved educator, mentor and faculty friend. She was born in St. Augustine, Florida to Isaac and Lucille Elizabeth Hay, but spent most of her childhood with a twin brother and a younger sister in Melbourne. At the beginning of World War II, her father, a practicing physician and founder of the first local hospital in Melbourne, was enlisted in the US Army Medical Corp and had to move with the family, first to Biloxi, Mississippi, for a year and then to Fort Hayes, Kansas, before he was deployed to the Philippines and his wife and children moved back to Melbourne.

Photograph courtesy of Bjorn R. Olsen, MD, PhD

Although her childhood may have been somewhat difficult, Betty developed a strong interest in biology. In an interview, published in *Journal of Developmental Biology* in 2004, she confessed that biological structure was something that clicked with her in high school and how she developed a love for understanding the anatomy of animals and showing that to others. In Biloxi she also got interested in airplane mechanics, took a course and planned to get a pilot's license, but when her family moved back to Melbourne that plan did not work out. Instead, she ended up attending Smith College, where she served as house president, ran the weekly newspaper and was on the riding team. During her first college summer she taught horseback riding at a girl's camp in Fairfield, Vt., and whenever the girls brought in dead animals, as she later explained, she could not get enough of examining the organs of various animals. She graduated *summa cum laude* with a degree in Biological Sciences. During her sophomore year at Smith College, she had started to investigate the regeneration of amphibian limbs with Professor S. Meryl Rose and worked with Rose during the summers at the Marine Biological Laboratory in Woods Hole. Dr. Rose became her mentor and friend and convinced

*In tribute to their dedicated efforts to science and medicine, deceased members of the Harvard Faculty of Medicine (those at the rank of full or emeritus professor) receive a review of their life and contributions with a complete reflection, a **Memorial Minute**.*

her to pursue a career in biology by obtaining an MD degree instead of a PhD degree. Betty may have considered Harvard but applied to Johns Hopkins Medical School. As one of four women in her graduating class she received her Johns Hopkins MD degree in 1952.

In her first year at Johns Hopkins University her anatomy and histology interests led to her getting a laboratory spot so that she could pursue limb regeneration studies during the year in addition to working with Professor Rose at Woods Hole in the summer. After graduation and an internship year, she was appointed Instructor in the Anatomy Department at Johns Hopkins in 1953. In that position she continued her work on amphibian limb regeneration, but her technical procedures took a significant step forward in 1954 when she learned what could be accomplished by electron microscopy. Using the microscope available at Johns Hopkins School of Public Health, she started investigations of embryological processes. Apparently unhappy with the quality of her images, she started travelling to New York City to seek advice about electron microscopy from Keith Porter and George Palade, experts in the field at Rockefeller Institute for Medical Research.

Across the street from Rockefeller, at Cornell University Medical College, was Dr. Don W. Fawcett, who had been working with Porter and Palade. Appointed Chair of the Department of Anatomy at Cornell in 1955, Fawcett built a thriving department and initiated advanced cell and tissue studies with the electron microscope. In 1956 Betty was promoted to Assistant Professor of Anatomy at Johns Hopkins, but with her growing interests in electron microscopy she accepted Fawcett's offer in 1957 to run his Cornell histology course as Assistant Professor of Anatomy. Donald A. Fishman, a medical student at Cornell who had been working on amphibian limb regeneration as an undergraduate student, joined her lab and together they traced the origin of cells in the regeneration blastema. The work led to two papers (Hay, E.D. and D.A. Fishman (1961) "Origin of the blastema in regenerating limbs of the newt *Triturus cristatus*". *Dev. Biol.* 3: 26-59; Fishman, D.A. and E.D. Hay (1962 "Origin of osteoclasts from mononuclear leucocytes in regenerating newt limbs". *Anat. Rec.* 143: 329-338.) The work led to the important discovery that mononuclear cells in blood are the source of bone-digesting osteoclasts. In 1960 Fawcett became the Hersey Professor of Anatomy and Chair of the Anatomy Department at Harvard Medical School and Betty moved with him as Assistant Professor.

In this new position, she continued her electron microscopy work on regeneration of limbs in salamanders. Together with a postdoctoral fellow she made the discovery that regeneration of limbs included synthesis of collagens by both fibroblasts and epithelial cells. At the time, epithelial collagen production was a novel discovery and was met with considerable skepticism by collagen "experts". Their strong arguments that her data had to be wrong or misinterpreted, were hard to take, but they stimulated Betty to work harder, with the goal of showing that epithelial cells can, in fact, secrete collagenous proteins. Working with her postdocs on the development of the chick cornea, she provided data demonstrating that epithelial cells produce the collagen in their basement membranes and that composition and structure of the extracellular matrix is essential for the formation of cellular cytoskeletons, cell shapes, cell migration and control of cellular growth and differentiation.

These discoveries finally led to the edition and publication of “Cell Biology of the Extracellular Matrix”, first in 1981, and followed by a second edition, published in 1991.

In 1969 Betty accepted the Louise Foote Pfeiffer Professorship of Embryology. Six years later, when Fawcett decided to leave his position as Chair of the Anatomy Department, she was elected Chair of Harvard’s Department of Anatomy and Cellular Biology in 1975. When the Departments of Anatomy and Cellular Biology and Cellular and Molecular Physiology were joined as the Department of Cell Biology in 1993, she retired from her chair position, but she continued to be a faculty member of Cell Biology until she retired in 2005.

Her scientific contributions to the roles of extracellular matrix in cellular regulation and tissue formation led to numerous honors and awards. These included Centennial and Henry Gray Awards from the American Association of Anatomists, the E.B. Wilson Medal from the American Society for Cell Biology and the FASEB Excellence in Science Award. She was elected to the National Academy of Sciences in 1984, and she served as President of the American Association for Anatomists (1981-1982), the American Society for Cell Biology (founded in 1960, Betty Hay was the first woman president 1976-1977) and the Society for Developmental Biology (1973-1974).

To faculty members, postdocs and students in her department Betty was a friend that did not lose sight of the fact that doing science is not only fun; it is glorious. She was loved and respected and could be both tough and gracious with both senior and junior people. Her love for gathering mushrooms and cooking mushroom dinners, the student and faculty dinners in her home with her cats at the table, and the annual reviews of her garden beauty are events that are difficult to forget. Her passion for science and the time and attention she gave her trainees was a precious gift. She never forgot that mentoring is all about giving, sharing yourself and your time. While she trained relatively few PhD students, she mentored many postdocs, even those of other faculty members and truly helped launch their careers. It is therefore no accident that so many of Betty’s postdocs went on to great careers in science, became departmental chairs, Associate Deans, Vice Presidents and Deans for Research and even a College President. Being a postdoc in Betty’s lab and department was truly special, in all aspects. Writing a paper with Betty Hay was a special experience; for her postdocs the process may at times have seemed more like passing a kidney stone, but for Betty, it was a process that mattered the most. She did not believe in taking postdoctoral data and writing the first draft herself; in her mind it was the responsibility of the postdoc to draft the paper. When that was done, the re-writing began. Betty would devote stretches of 3-4 hours of sitting side-by-side on her couch editing the text, line-by-line, sometimes word-by-word. In her mind, mentoring was also about preparing trainees for what they may need in their future careers. She often emphasized confidence; whether in her journal club and faculty research meetings or in presenting at national meetings, she felt that her mentees needed to own their science. When postdocs received a so-so review from a journal editor or a funding agency she told them that it was not the end of the world, but rather only the start of the fun.

Respectfully submitted,

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