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Anthony Mahowald

Tony Mahowald was a Jesuit for nearly twenty years, five of those a priest. Twenty-eight years ago he decided to forego the priesthood to focus on science.

Mahowald, a native of Minnesota, initially was a pre-med biology major at St. Johns University near his home town. His intention was to become a physician like his father, who had trained at the St. Louis University Medical School. But after his first year in college, he decided to train for the priesthood and a life of ministry and service.

Mahowald explains that after hearing about his older sisters positive experience at Marquette University with the Jesuits, he became attracted to their mission and joined them. Following the traditional four years of education in the classics, Mahowald chose to return to biology for his field of academic specialization, which he combined with the usual seminar training in philosophy at Spring Hill College in Mobile, Alabama. With the encouragement of the Jesuit order, he won an NSF predoctoral fellowship and moved to Johns Hopkins for graduate studies.

Mahowald remembers the late 50 s and early 60 s as a golden time in science. One of the first talks he attended after arriving at Hopkins was by Phil Hartman, who had just returned from the international genetics congress and reported on the Jacob-Monod theory of operons. To one interested in developmental biology, this clearly meant that genes would control other genes in multicellular organisms and that genetics would be required to decipher the mechanisms. This attracted Mahowald to the study of *Drosophila* with Ted Wright, who had just joined the faculty. *Drosophila* was the only genetically tractable organism available at the time, and Mahowald has studied it ever since.

After receiving his doctorate studying the formation of the cellular blastoderm and pole cells with the electron microscope, Mahowald moved to Woodstock College for four years of theology and preparation for his planned life as a Jesuit priest. But this was not a divorce from science, because he and five fellow Jesuit scientists established laboratories in the basement of one of Woodstock s 100-year old buildings (funded by the NSF and NASA, he gratefully acknowledges, as well as help from Army surplus). The group also commuted back to Hopkins weekly on their day off from theological studies for scientific research. Mahowald recounts how this was truly an epochal time in the Catholic Church to study theology because of the renewal occurring in Rome during the worldwide Vatican Council. It was a wonderful time to be able to continue in scientific research while also delving deeply into theology, scripture and other training involved in preparing for the priesthood. While some would wonder how scientific studies might fuse with theology, for those at Woodstock it was simply following in the Jesuit tradition of scholarly study, wherever it led.

After completing his theology studies and being ordained a priest, Mahowald moved to Marquette University, where he established his own laboratory, made some key discoveries relating to the continuity of polar granules throughout the life cycle of the germ line, taught cell biology to a large class, and also began ministerial duties. Mahowald somehow managed these two careers as biologist and priest until 1970, when he decided that he just could not do both. With the tempest that society was during the late 60s and a similar ferment in Catholic theology, it became increasingly difficult to manage the two careers responsibly. This led, as Mahowald recalls, to the hardest decision of my life, to leave the Jesuits and concentrate on science, while retaining his religious commitment.

In 1970, Mahowald moved to the Institute for Cancer Research at Fox Chase in Philadelphia, where he was a visiting scientist for two years in the laboratories of Jack Schultz and Len Cohen. But the excitement of an academic campus was more to his liking than the relative isolation of a research institute. Private institutions are essential to science, but I was more comfortable in the academic environment, he said of his decision to leave Fox Chase. Mahowald found a tenured position at Indiana University. He admits, I was lucky. Times were much different back then, and tenured jobs were much more available.

Mahowald s first important contribution was his ultrastructural description of germinal granules in flies, midges and frogs. He also showed ultrastructural evidence that granules were continuous throughout the life cycle of germ cells. His germ plasm work culminated in a set of experiments with Karl Illmensee at Indiana in which they demonstrated that the *Drosophila* germ plasm could autonomously function in other locations in the embryo, by transplanting the posterior germ plasm to both the anterior tip and the mid-ventral regions to form functional germ cells. Following this work, he moved on to a genetic approach to the origin of germ cells, with a major screen of the X-chromosome for grandchildless mutations. Although no mutations of this type have been found on the X-chromosome by his or any lab, Eric Wieschaus sent him a mutation in the tudor locus that eliminated germ cells, and Bob Boswell and Mahowald demonstrated that tudor was required for polar granule formation. Tudor is thought to be a key player in establishing primordial germ cells in *Drosophila*.

While at Indiana, Mahowald and his colleagues pursued two further aspects of oogenesis. Working with his postdocs, Allan Spradling and Gail Waring, they were able to identify two loci coding for the major chorionic proteins, leading to the discovery that these loci were amplified during oogenesis. He also began the study of vitellogenesis with an outstanding group of graduate students, work that continues to the present.

Asked about the recent results in Scotland producing Dolly the sheep, Mahowald describes it as a paradigm shift in our understanding of the reversibility of steps involved in differentiation. Mahowald recalls the effort made by many in previous decades to obtain normal adult frogs and flies with nuclei from adult cells with no success. Because of the uniqueness of Wilmut's result with only one successful animal, he agrees with the recent debate regarding the need to duplicate the result. It is still a puzzle why these nuclear transplantations are possible in some organisms and not others, such as frogs or mice.

In 1982 Mahowald moved to Cleveland to become Chair of the Department of Developmental Genetics and Anatomy at Case Western Reserve University, and in 1988 he became Chair of the newly formed Department of Genetics. During his eight years in Cleveland, Mahowald continued to study many mutations derived from the grandchildless screen which had led to the discovery of a number of maternal effects of female sterile mutations. From this work, Mahowald says, we recognized that there were two classes of female sterile loci: those with many alleles, such as *yolkless* and *gastrulation defective*, and loci with only one or at most two alleles.

The analysis of loci with rare female sterile alleles, with the help of a new postdoctoral fellow, Norbert Perrimon, and a visiting scientist from Ball State, Lee Engstrom, led to the discovery of a major new set of genes whose role is essential in patterning of the embryo. As many as 70% of the class of essential genes are also required during oogenesis. Currently Mahowald's work concentrates on exploring the genetic and molecular basis for germ line sex determination. We work on the molecular analysis of *ovo* and its homolog in mice and on the somatic cells that we believe play a major role in controlling expression of sex-lethal in the germline.

Since 1990, Mahowald has served as Louis Block Professor and Chair of the Department of Molecular Genetics and Cell Biology at the University of Chicago, and Chair of the Committee on Developmental Biology. While he claims he has been Chairman too long (16 years counting Case Western and Chicago combined), he sees it as a way of helping others, which brings a lot of pleasure to the complex life of joining chairmanship with his research and teaching. He admits that it's easier to teach biology lecture and laboratory courses now that he has graduate teaching assistants to help, compared to his early years when there was little help. Mahowald says, teaching excites me because I enjoy explaining development to students. Mahowald's colleague Elaine Fuchs says of Mahowald, Tony's background as a Jesuit priest, coupled with his marriage to a feminist and of course his stature in the scientific community, were exactly the credentials needed to successfully chair a department of talented, outspoken and diverse scientists, with a large number of dynamic and confident women. I don't think anyone in the department ever questions Tony's integrity or his motives: he always tries to do what he feels is right and he always acts in a humble and unselfish manner. He genuinely enjoys science and the scientific community and this is always reflected through his actions. Such traits are very rare in leadership, and we are extremely fortunate to have him as our Chair.

Mahowald's move to Cleveland was principally motivated by the chance for him and his wife, Mary, to work together on the same campus. In Indiana, he had worked in Bloomington and she was at the Indianapolis campus, more than an hour's drive away. They have found the opportunity to work on the same campus again at the University of Chicago, where Mary is a professor in the Center for Clinical Medical Ethics, the Department of Obstetrics & Gynecology, and the College. Most of her students are doctors who come for a year's fellowship and take her course in Foundations of Bioethics.

The Mahowalds have three children: Maureen, the eldest, has just finished her master's degree in molecular biology at Princeton and is taking a year off to figure out what she wants to do next. Their second daughter, Lisa, finished her undergraduate work in atmospheric physics at Harvard last year, and has been working this year in Chicago at a law clinic for the disabled; she will start Law School at New York University in the fall and plans to focus on public service law. The Mahowalds son, Mike, is a biology major at Swarthmore College, now taking the spring semester of his junior year to work in the rain forest in Costa Rica. The Mahowalds claim to be surprised but pleased that their children have all studied science.

Mahowald joined the ASCB as a graduate student soon after its founding in 1960. Reflecting the loyalty of many of the Society's long-standing members, he says, I have always gone to the meeting because I know so many people there, although with the huge influx of younger scientists, this is no longer as true. He views the ASCB as his society, in part because of the collegial feeling of the Annual Meeting. Mahowald was elected to Council in 1995, and is currently serving the last year of his term. He especially enjoys working with younger members of the Council who are so enthusiastic; he's particularly impressed that the Council has not shied away from tackling some major issues during his tenure. Mahowald has also served as President of the Society for Developmental Biology, which he notes voted to merge with the ASCB during his tenure as President, and as Editor-in-Chief of *Developmental Biology*. Mahowald remembers that this required him to read seriously over 250 manuscripts a year.

Upon election to the National Academy of Sciences in 1994, Mahowald was asked to join the Committee

on Space Biology and Medicine of the National Research Council, to provide guidance on the research program being performed by NASA. He reflects that this assignment has allowed him to learn a lot about space biology, a field he knew little about when he began to serve. The Committee will release a report on NASA's space biology program this summer. Taking advantage of Mahowald's exposure to NASA biology research, ASCB President Elizabeth Blackburn recently invited Mahowald to serve on an ad hoc committee to develop an ASCB policy on NASA research. The Committee is being chaired by former ASCB President Donald Brown; also serving are fellow ASCB members Ursula Goodenough, Steve Harrison, Elliot Meyerowitz (also on the Committee on Space Biology and Medicine), Chris Somerville, and Andrew Staehelin. The Committee is scheduled to make its recommendations to the ASCB Council by this summer.

Outside of his work, Mahowald likes to spend time reading, especially history and biography, as well as playing tennis and golf when he is on vacation. Some of his favorite books have been Manchester's volumes on Churchill. Recently, Mahowald's daughter, Maureen, gave him a whole library of books on the French Revolution because he had mentioned his interest in learning more about this watershed in history. He also enjoys going to Chicago's Lyric Opera with his brother, who is a mathematician at Northwestern University and an opera aficionado.