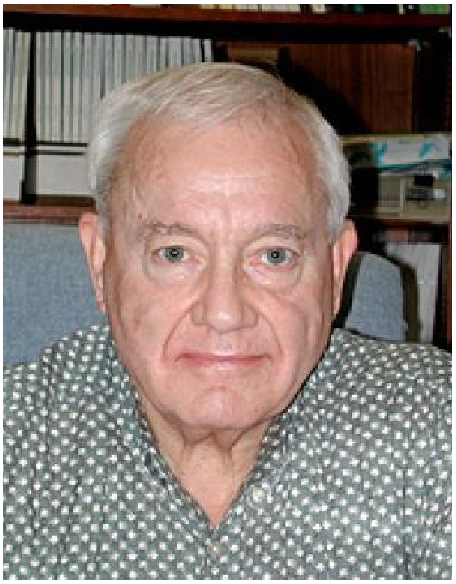
Joe L. Key



I grew up in Obion County, Tennessee. After obtaining an undergraduate degree in agriculture at the University of Tennessee at Martin, I, like several other ASPB Pioneers, began my career as a plant biology researcher at the University of Illinois. I completed a PhD in 1959 with Jack ("JB") Hanson studying auxin physiology, a topic of intense interest at that time. In JB's lab, I demonstrated that 2,4-D, a potent herbicide at high concentrations, mimicked auxin activities at low concentrations and induced changes in nucleic acid metabolism. I went to the University of California, Davis, in 1960 on an NSF postdoctoral fellowship to study biochemistry, but I relinquished the fellowship after six months when I was appointed as an assistant professor in botany.

In July 1962, I accepted an associate professorship at Purdue University and there continued to explore the roles of nucleic acids in auxin-regulated responses, publishing papers in *Plant Physiology,* the *Journal of Molecular Biology,* and the *Proceedings of the National Academy of Sciences*. This work demonstrated the essential roles of RNA and protein synthesis in mediating auxin-enhanced cell elongation.

I was recognized for the discovery of "DNA-like RNA," or D-RNA, which is now known to constitute messenger RNA in plants. The A-rich D-RNA was separated from tRNA and rRNA by a standard RNA analysis procedure. Further studies demonstrated that D-RNA was polyadenylated in varying lengths at the 3′ end. It could be further fractionated into two types of mRNAs: one with a mean half-life of about one hour and another, larger fraction with a half-life ranging from a few to several hours.

In 1966 I was promoted to professor of plant physiology at Purdue. My laboratory continued research at the forefront of transcriptional and translational regulation on auxin-induced growth by studying the behavior of ribosomes, in particular polyribosome formation, and this work was extended to projects investigating other plant developmental and stress responses. Chu-Yung ("CY") Lin, a postdoc in the lab, performed a technically demanding study on anaerobiosis in soybean seedlings, showing that the response was characterized by a rapid readout of polyribosomes and the accumulation of monoribosomes. After returning to aerobic conditions, a rapid reaccumulation of polyribosomes occurred, independent of RNA synthesis. This research was the beginning of a multidecade-long collaboration and friendship with CY. The years in my laboratory at Purdue were fruitful as postdocs, collaborators, and students established the requirement of RNA and protein synthesis for auxin-regulated cell elongation, with me as an active, hands-on participant at the bench.

In 1969, attracted by the commitment of a new president to build the research enterprise of a land-grant institution, I moved to the University of Georgia (UGA). The laboratory became a magnet for young scientists interested in studying the molecular mechanisms of plant physiological responses. Work at Purdue had clearly established that auxin regulation of plant growth was associated with changes in gene expression, and at UGA this became the focus of my lab. The newest techniques available to study tRNAs, tRNA synthetases, polyribosomes, RNA polymerases, transcriptional elements, and the role of poly(A) RNAs were used, leading to cloning cDNAs that were both up- and down-regulated by auxin. Two auxin-regulated genes, from what turned out to be a large multigene family of up-regulated transcripts, were isolated, sequenced, and characterized.

This was the time of Maxam–Gilbert DNA sequencing using three-foot-long acrylamide gels, hours in the cold room extracting RNA, plasmid isolation on cesium chloride gradients, and lots of 32P-labeling. Obtaining a "full-length" cDNA or genomic sequence, including the promoter region, was

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a call for celebration. In a fraction of the time it took to get a 250–300 nucleotide sequence in those days, one can now obtain the complete genome sequence of an organism. Not many plant biologists were using those new technologies at the time, which made my laboratory attractive to young scientists eager to learn and apply them. I was fortunate to choose postdoctoral fellows and graduate students who were able to work together, as well as independently, which fostered many friendships during their few years of residence in the lab.

In the late 1970s, CY and I began to investigate whether heat shock would induce a significant transcriptional and translational response in soybeans. Recent work in Drosophila had shown major changes in RNAs and proteins synthesized during a shift to a higher temperature, a phenomenon scientists referred to as "heat shock." This furthered a desire to continue to focus on understanding protein synthetic responses to environmental changes. The discovery in plants of the now-recognized ubiquitous heat shock response opened a new research direction and attracted another group of scientists engaged in studying the response at the transcriptional and translational level. This period of research into the mechanisms of auxin-regulated and heat-induced responses was groundbreaking in terms of applying state-of-the-art recombinant DNA methods to these questions, and my lab was one of the first to clone and study specific genes from plants.

While leading and mentoring a productive research laboratory, I stepped into several major research administrative positions at UGA and beyond. I chaired the Division of Biological Sciences at UGA from 1972 to 1983, overseeing an expansion in faculty in the disciplines of genetics and molecular plant biology. Recognizing the value of recombinant DNA technology to agriculture before USDA did, I worked alongside other colleagues to get USDA to request funding from Congress for what became known as the USDA Competitive Research Grants Office (CRGO). It took concerted lobbying by members of the Senate and the president's Office of Science and Technology Policy to keep this funding in the budget because the House Appropriations Committee chair always zeroed the program out of the House budget. When it was finally in place, the program brought additional peer-reviewed funding and scientific rigor to plant biology research. I served as the first scientific director of CRGO.

During a leave from Georgia (1983–1985), I served as executive vice president for research at the Agrigenetics Corporation, directing the lab activities from Boulder, Colorado, and supporting U.S. and international scientists whose research had the potential to change plant agriculture. It was my vision for a modern agricultural research mission that led me to accept the role of leading the Agrigenetics research program for this novel commercial enterprise. Agrigenetics established research labs in Boulder and Madison, Wisconsin, and purchased a few relatively small seed companies throughout the western United States. It provided a large group of renowned plant scientists with over $50 million for basic plant science research, the results of which were to be funneled into the Boulder and Madison research laboratories that were charged with applying the results to commercial agriculture.

Upon my return to Georgia, the university president encouraged me to become vice president for research (who, by statute, also served as the executive vice president of the Research Foundation), thereby placing an active research scientist at the helm of a growing and respected research faculty. With insight into the needs of researchers, I saw an opportunity to make a significant difference in the punishing cycle of grant funding for individual faculty members. Funding gaps in grants would often force faculty to terminate highly trained scientists, disrupting research productivity and the lives of personnel. I wanted a mechanism to provide seed money so that good ideas could be advanced to a point where they could compete for funding. I also saw an opportunity to provide funds to the humanities, which had fewer grant opportunities. As executive vice president, I was able to persuade the board of the Research Foundation to approve budgets that included funds to address these concerns, using a combination of indirect costs recovery and revenues received from commercialization of faculty and staff inventions.

Continuing my strongly held view of the need for collaboration

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between basic and applied research scientists, I worked with my long-time friend and colleague Leon Dure to implement creation of the Plant Center at UGA. Leon and I believed that a structure was needed to foster interaction between laboratories doing molecular and biochemical research in the plant sciences and, equally important, to get basic scientific discoveries applied to practical problems in agriculture. In the late 1980s, the center was formally recognized at UGA with a continuing budget, and it now has more than 60 faculty from nine departments and more than 130 students, postdocs, and staff. The center's director is elected by members of the faculty and may serve one or more years. The center provides funding for students and faculty to support travel to meetings and conferences. It also sponsors an annual symposium and an annual retreat where students, postdocs, and faculty may present their research. I was honored as founder during the 30th year anniversary symposium, where the Plant Center reported that its members had developed more than 40 new plant varieties and held more than 15 utility patents covering plant-related technologies throughout the world.

Throughout my career, I served ASPP/ASPB in leadership roles, including as president of the Midwest Section in 1968–1969 and national president of ASPP in 1976–1977. In recognition of my service to the science of plant biology, I received the Charles Reid Barnes Lifetime Membership Award in 2000 and the Adolph E. Gude, Jr., Award in 2016.

Until my retirement in 2000, I continued to wear dual hats as research administrator and active laboratory researcher. Former UGA President Michael F. Adams stated in a public relations press release that "Joe Key's enlightened leadership has been instrumental in making the University of Georgia one of the top public research institutions in America. By solidifying our strengths in traditional research areas, and moving vigorously into new fields of scientific inquiry, Joe has helped position the university to contribute significantly to the growth of Georgia's economy in the 21st century. The University and the State are indebted to him for his extraordinary vision, dedication, and leadership."

I am proud of having had over 30 years of funding from both NIH and DOE that provided laboratory members the liberty to explore new directions and do creative, cutting-edge research. The lab's contributions to understanding auxin regulation of nucleic acid metabolism and gene expression, along with later work defining parameters of the regulation and components of the plant heat shock response, provided the foundation for many other discoveries by those trained in my group and the wider plant biology community. The list of individuals who spent time at Purdue and UGA over the course of my career, and the lasting friendships and collaborations that resulted, serve as a strong testament to how the lab's environment and discoveries fostered excitement for and dedication to advancing plant biology.