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# Reflections on Mentoring Undergraduate Research

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## Reflections on Mentoring Undergraduate Research

by:

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*“My approach to undergraduate mentoring is: expecting and accepting nothing but the highest standards for research, while providing all the encouragement and resources possible to enable the student to reach those standards.”*



People might be surprised by the significant contributions undergraduates make in the research enterprise at the University of Kentucky. Over my 28 years at UK, more than 100 undergraduates have performed research in my laboratory. Of these students, many went on to graduate school for the Ph.D. in chemistry, biochemistry, pharmacology, toxicology, or related fields. Others are now medical professionals, industrial chemists, professors, and lawyers. More than 40 of the 270 refereed papers and three books published from my laboratory were co-authored by undergraduates. Two of my undergraduate research students have won national awards, one for his scholarship and research results, and the other for her potential.

The great majority of undergraduates who have performed research under my aegis were from Appalachia and, especially in more recent times, the majority was female. Both women and persons from Appalachia are highly under represented in the discipline of chemistry. Accordingly, I have made a deliberate effort to recruit female and Appalachian undergraduate students to my laboratory to perform independent research. Together with similar efforts with graduate students, these approaches led to my receiving the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring from President Clinton in the White House.

The main research thrusts of my laboratory deal with National Institutes of Health (NIH) funded research on oxidative stress in the brains of persons with Alzheimer's disease (AD). Students who



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perform research in my laboratory are involved in cutting-edge science on oxidative stress, exemplified by our findings that (1) a peptide that accumulates in the brains of AD patients causes oxidative damage to proteins and lipids in neurons; (2) there exist oxidized proteins in AD brains; and (3) proteomics has been used for the first time to identify specific oxidatively modified proteins in AD brains. New insights into potential mechanisms for neurodegeneration and their amelioration by endogenous and exogenous antioxidants have arisen from this research.

Undergraduates are full partners in these endeavors. My approach to undergraduate mentoring is exactly the approach that was applied to me when I was an undergraduate chemistry major performing independent research: expecting and accepting nothing but the highest standards for research, while providing all the encouragement and resources possible to enable the student to reach those standards. I treat all my undergraduate students like my graduate students. I expect them to participate fully in productive research, in research group meetings, in being up-to-date on the current literature on Alzheimer's disease, in articulating what their research is about to others, and going to national meetings to present their research to our scientific peers. I spend practice time with the students prior to all presentations; I make sure that their research projects are progressing well; I always encourage the students in their research and to see the humanity behind the experiments they perform.

My first UK undergraduate research students in 1976 were James Oeswein and Eddie Prunty of Eastern Kentucky. Each was the first of his family to attend college, and each performed excellent studies related to another neurodegenerative disorder, Huntington's disease. Jimmy Oeswein is co-author of a scientific paper in *Nature*, arguably one of the most prestigious scientific journals. Eddie is a co-author of a paper in *The Annals of Neurology*, which fit his career plans: Eddie is now a physician in Western Kentucky. Jimmy went to the University of Florida for his Ph.D. in biochemistry and was employed by Genentech, a large biotechnology firm. My most recent undergraduate student is Robin Petroze, from Northern Kentucky. Robin was a recipient of the prestigious Beckman Fellowship, based on a national competition. Robin has presented her research related to AD at the American Chemical Society National Meeting in New Orleans and at the World Neuroscience Meeting in Prague, Czechoslovakia. She will be going to the University of Cincinnati for medical school, after

completing a year in Jamaica to help underprivileged children with life skills. Robin soon will have at least one refereed scientific paper published based on her research.

One might ask, "How do these undergraduate students find the extensive time to spend on research necessary to produce at this level, while taking a full academic load?" I still do not know the complete answer, but based on the large number of highly successful students who have studied in my laboratory, I think three characteristics are prominent. These students are incredibly bright, incredibly focused, and incredibly nice people. These characteristics are important because my graduate students, who provide the day-to-day, hands-on supervision of these undergraduates, are far more willing to help undergraduates whom the graduate students perceive as having drive, ambition, a keen intellect, and are nice people. This symbiosis helps the graduate student with her/his dissertation research and helps the undergraduate gain valuable research experience at the leading edge of neurochemistry.

In addition to UK undergraduate researchers, I have been privileged to have numerous non-UK undergraduates also perform independent research under my supervision. These students have been supported by NSF grants for "Research Experiences for Undergraduates" received by the Department of Chemistry and by the Center of Membrane Sciences.

For me, the satisfaction, indeed joy, of seeing an undergraduate learn the intricacies of the brain and how the brain is altered in neurodegenerative disorders such as AD, provides rewards for the efforts involved in mentoring undergraduates. For the University of Kentucky, it is my view that other tangible rewards accrue from undergraduate research, including the bridging of laboratory and classroom learning increases satisfaction of the student experience in undergraduate education; and the student who was mentored, one day will be a mentor, therefore, the skills learned at UK will exponentially radiate to others.

Based on one person's reflections of undergraduate research mentoring, which I suspect are replicated throughout the University of Kentucky, I hope that no one will be surprised at the contributions undergraduates make to the research enterprise at UK. I have had the privilege of mentoring this large group of undergraduate researchers over my years at UK. I look forward to continued involvement with undergraduate research throughout the remainder of my career.