

NATIONAL SCIENCE FOUNDATION, INTEGRATED GRADUATE EDUCATION AND RESEARCH TRAINING (IGERT) GRANT

Title: Macromolecular Interfaces with Life Sciences (*MILES*): Oxidative Processes

Principal Investigators: S. E. Duncan, T. E. Long, and C. D. Thatcher

Project Summary

The newly funded \$3.25M *MILES*-IGERT grant will contribute significantly to the proposed initial focus of the Food, Nutrition, and Health (FNH) initiative, which is part of the Institute for Biomedical and Public Health Sciences (IBPHS) at Virginia Tech. FNH plans to focus on obesity research and the *MILES*-IGERT grant will address oxidative processes that are related to obesity and its associated health conditions such as diabetes and cardiovascular diseases. Several of the research platforms of the *MILES*-IGERT grant, which are described below, will ingrate with research goals of the planned FNH initiative.

Vision, Goals and Thematic Basis:

Many boundaries at the chemistry-biology interface remain unexplored and represent unique opportunities for the discovery of advanced technologies and the education of interdisciplinary scientists and engineers. Oxidation processes occur within both synthetic macromolecules and biological systems, offering a common theoretical base. Oxygen-centered radicals are implicated as intermediates in key chemical and biological processes such as lipid oxidation, cellular aging and product deterioration, as well as certain enzyme-mediated processes. The profound irony underlying all oxidation chemistry is that, in general terms at least, the same element that nature uses to sustain and regenerate life also plays a role in aging, disease, and death. Oxidative stress is implicated in many chronic diseases, including cancer, diabetes, obesity and the compromise of immune function.

Integration of Research and Education:

Fifteen interdisciplinary research faculty in four colleges at Virginia Tech will collaborate with domestic and international universities, industries and national laboratories to provide unique cooperative research, multidisciplinary education, and outreach experiences for **36 graduate students**.

The Program will prepare doctoral-level candidates in chemistry, engineering, and life sciences as future leaders in academia, industry and government. The research efforts will include basic through applied research in four areas: 1) Fundamental investigations of oxygen-centered free radical mechanisms; 2) Oxidation in bio-derived monomers and macromolecular synthesis; 3) Oxidation control mechanisms in complex matrices; and 4) Oxidation processes in human and animal aging and disease.

Core Faculty	Research and Education Training (Department Abbreviations⁴)	Role in <i>MILES</i> Research
Timothy E. Long	Macromolecular Chemistry (CHEM)	Macromolecular Synthesis and Characterization
James M. Tanko	Free Radical Chemistry (CHEM)	Free Radical Mechanisms
Thomas C. Ward	Macromolecular Chemistry (CHEM)	Macromolecular Aging and Performance
Garth L. Wilkes	Macromolecular Eng (CHEE).	Macromolecular Morphology and Structure
Andrea M. Dietrich	Environmental Eng. (CEE)	Oxidants in Water Systems
Joseph E. Marcy	Food Chemistry (FST)	Macromolecular Food Packaging
Sean O'Keefe	Food Chemistry (FST)	Flavor and Lipid Chemistry
Susan E. Duncan	Food Chemistry; Nutr (FST)	Multiphase Biological Systems
Korinn Saker	Nutrition (LACS)	Control of Cellular Oxidative Stress
Craig D. Thatcher ²	Nutritional Physiol. (LACS)	Antioxidants and Nutrition
Janet W. Rankin	Nutritional Physiol. (HNFE)	Oxidative Stress and Metabolism
Michael Houston	Chemistry/Biochem. (HNFE)	Oxidative Stress in Cellular Metabolism
Hara Misra	Biochemistry (Osteo Med)	Cellular Oxidation/Antioxidation
David R. Bevan	Biochemistry (BCHM)	Biomacromolecular Modeling
Edward J. Smith	Molecular Genetics (APS)	Genomic Analysis of Oxidation and Aging

Key features of this program for the student includes:

- Competitive graduate stipends with at least 21 months at \$30,000 per year and other months of support at nationally competitive levels, full tuition and fee waivers, funds towards a computer purchase, full travel support for travel, internships, and international experiences.
- The opportunity to earn a Ph.D. degree in the student's home department and a *MILES*-IGERT Certificate.
- Participate in a unique educational framework and collaborative interdisciplinary research program, using oxidative processes as the thematic basis for scientific connectivity that bridges the gap between traditional macromolecular science and evolving biological disciplines.

- Participate in a leadership development program that involves development and presentation of an electronic portfolio, students teaching students, academic and industrial seminars, industrial internships, and international experiences.
- Participate with an Industry Advisory Board in the development of entrepreneurial research initiatives.

Broader Impacts:

The university's education and research infrastructure will be strengthened considerably by this interdisciplinary program design that crosses the boundaries of traditional academic disciplines. Broad societal impact will result from improved control of free radical and oxidative processes in biological and macromolecular systems, yielding important advances in nutrition, biomedical science and engineering, food biochemistry and functionality, and sustainable polymeric materials from bio-derived precursors. This training program will contribute to a new generation of professionals prepared to move society into an era of