

Broader Impacts NSF award in biochemistry

Scientific Impact.

The proposed research is a significant step toward defining a novel mechanism that controls mitochondrial metabolism in plants. Overall, a better understanding of the regulation of mitochondrial function is needed to explain plant energy balance and biomass accumulation, and will already allow us to improve both models of global climate change and crop yields for food and fuel.

Education and Outreach.

Overview:

Broader impacts in education and outreach will be carried out in three areas, research training, hands on science for 13-18 year old girls through the Girls Inc. program in Holyoke, MA, and community outreach sponsored by the local chapter of the League of Women Voters. Letters of support from the latter two groups are attached.

Research training:

First, the proposed research will provide training for a postdoctoral scientist, a graduate student and undergraduates. I have a long record of providing lab members with the resources and intellectual environment to formulate scientific questions and to design experiments to solve them. I also encourage and facilitate graduate students and postdocs to obtain training appropriate to their career goals, and members from the lab have gone on to careers in K-12 outreach, Community Colleges, Research Universities, high schools and industry.

This project will also engage a minimum of two undergraduates working with the graduate student or postdoc on independent projects. These students can complete experiments measuring respiration by oxygen consumption in the *shot1* mutant compared to wt, participate in western analysis of cytochrome c and other ET components as described in Aim 1. Screening for transgenic lines with estradiol regulated RNA and testing estradiol effects on phenotypes would also be a suitable undergraduate project over the course of the grant. Testing the phenotypes of new mTERF mutants would be another area for undergraduate participation.

I have sponsored over 50 undergraduates to perform laboratory research, which has led to 14 student authorships in peer reviewed journals, including two minority women, one as first author. Since moving to UMass in Jan. 2011, I have sponsored three independent study students, and currently have five undergraduates in the lab, including two minority students, as well as two high school students (one minority). One independent study student, who graduated in May 2012, was hired by Genzyme. I will continue to recruit minority students through the excellent UMass STEM Diversity Institute, which coordinates programs such as the Louis Stokes Alliance for Minority Participation.

Science outreach:

The UMass College of Natural Sciences formed a partnership with Girls Inc. of Holyoke, MA (<https://www.girlsinholyoke.org/>) to provide four weeks of hands-on, science workshops for teenage girls in the summer of 2013. Holyoke schools have up to a 50% high school dropout rate in a county with the state's second-lowest median income and a high percentage of minorities underrepresented in science. The workshops are part of a national Girls Inc. program called "Eureka!" that enrolls rising 8th graders to commit to participation in four weeks of STEM

activities for five summers. In the summer of 2013, I piloted a two-morning workshop called “Plants: Inside and out”, with nine teenage girls (mostly 13 years old), all but one of whom were minorities. The goal was to expose these girls to the diversity of plant structures at the microscopic level, review the central dogma of DNA to RNA to protein, and engage them in a laboratory experience separating plant proteins by gel electrophoresis to see the “inside” of plants. For the workshop I used available undergraduate laboratory space, dissecting microscopes, microfuges, electrophoresis and sample preparation equipment. Girls Inc. provided a staff member familiar with the girls, and an undergraduate and high school intern from my lab participated with me in teaching the workshop. The girls prepared protein from plants obtained from university grounds and ran SDS gels, which allowed them to see the major protein involved in carbon fixation (Rubisco). They were able to look in detail at pollen, seeds, and other plant structures under dissecting microscopes. We also translated mRNA sequences into messages and folded paper models of DNA and tRNA. This pilot workshop will be further developed and complete instructions and tips will be formalized for the Girls Inc. program and posted on my website. This workshop will be continued, and in consultation with Girls Inc. more advanced material will be developed for girls who continue every summer throughout high school. Girls Inc. also evaluates the summer experience to understand the effectiveness of their programs. I have committed to participating each summer for five years, offering either one or two workshops as needed by program enrollment. Another goal is to be able to offer an older girl, who has participated in the program, an internship in the lab. Sarah Dunton, Director of Education for Girls Inc. of Holyoke (see letter of collaboration) is committed to working with me and other faculty at U Mass to increase the long term effectiveness of the program.

Community Outreach:

In a third effort I propose to develop a series of presentations about “Genetically modified plants – from food to the laboratory”, under the sponsorship of the local chapter of the League of Women Voters (see letter of support). The safety of genetically modified foods continues to be an area of public concern. This is not only a national and global issue, but also a local issue. Western Massachusetts has a significant farming community and organic and “locavore” food “consciousness”. Much of the general public lacks a basic understanding of how genetically modified plants are generated, which fuels skepticism about their safety. One such talk will be presented every six months over the course of the grant. The goal is to focus on the science, and not to advocate GMOs or big agriculture, but rather to provide sufficient information and understanding so that individuals can make their own decisions concerning the safety and use of this technology. The first four topics will be: 1) History of recombinant DNA modification of plants; 2) the development and biochemistry of herbicide resistance, 3) the development and biochemistry of insect resistance; 4) introducing novel traits and advancing plant biology, the latter using examples from my own research. I have previously taught a five session class with this material to in-service teachers. Subsequent talk topics will depend in part on the interests of the community of individuals attending, but I am considering topics such as preserving the diversity of agricultural germplasm and advancing agriculture through molecular breeding. The venue will be the Amherst Public Library, which has space for presentations (for a nominal fee) in a room with a capacity for 100 people. Talks will be advertised through the library website and the League of Women Voters website and will begin with 30 minutes for mingling with some refreshments (provided by the League), followed by a 45 minute presentation during which the audience will be encouraged to ask questions to generate discussion. A further goal is to feature the informational material developed as part of my lab website.