Provost's Learning Innovations Grant for Faculty  
Request for Full Proposal  
2001-2002

Please send your completed grant proposal (4 pages, plus attachments), one original and eleven copies, to Linda Jones, 4000 Eastman  
by 4:30 p.m.  
Friday, February 16, 2001.  
No hand written proposals will be accepted.  
Notification of awards will be made by Friday, March 16, 2001.

Project Title:  
MICROARRAY TECHNOLOGY

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I. Title and Summary:

Microarray Technology  
Dr. Irene M. Evans  
Department of Biological Sciences  
College of Science  
Rochester Institute of Technology

Microarray technology is a technology that is revolutionizing biology. A microarray or DNA chip is a device that has gene (DNA) sequences on it. Using microarray technology, it is possible to look at the expression of many/all the genes of an organism at any one time under specific conditions. This replaces the reductionist method wherein one gene was observed to see how its expression changed under varying conditions. The project I am proposing, for example, will examine the expression of all the 6,200 genes in the yeast genome. An example of a yeast microarray such as we will use is shown in the appendix. Each spot represents a gene (DNA) sequence that has been put onto a surface. If the gene is expressed (active) under one set of conditions (active growth), there is a red spot on the microarray. If the gene is expressed under a different set of conditions, (depletion of carbon source), there is a green spot on the array. Where there are yellow spots, the gene was active under both conditions. As mentioned, the array has all known yeast genes present on it.

Before the advent of this technology, scientists examined one gene at a time and tried to guess how this gene might coordinate with all the other genes that were "on" in a cell or tissue. Rather than one gene at a time, scientists now can use a microarray printer and reader to spot and analyze thousands of genes in one experiment. For example, one can determine which genes are "on" in a breast cancer cell as well as which genes are switched off. The gene expression pattern in the cancer cell can then be compared with a normal breast cell. Such analysis, which has just begun, has already suggested new targets for cancer chemotherapy.

I propose to develop a course in microarray technology to be taught to undergraduate students in our biotechnology program. I am currently a member of GCAT, Genome Consortium for Active Teaching (See printout of GCAT web site in appendix). GCAT is a NSF-funded project, which provides the microarrays to undergraduate institutions at a nominal cost. The cost of the arrays also includes scanning them and providing the scanned data on a CD for analysis. As a member of GCAT, I must share my experiences in developing an undergraduate course with other members of GCAT. A handful of faculty at other undergraduate institutions have already begun to develop such a course so I will have the benefit of their experiences (See appendix for listing of faculty and projects). I am asking for release time and funding for undergraduate salaries for students to help develop the laboratory modules. This funding will also be used to develop a website that will be used by the class to display their microarray images. This website will also be linked to GCAT. I originally asked for an
upgraded computer with enough memory to be able to analyze the data that will be provided on the CD; I have transferred this request to my department as suggested by the letter inviting me to submit a full proposal.

In the past it would not be possible to introduce state of the art technology like microarrays to an undergraduate laboratory. This is due to the prohibitive cost of the technology and the need to have advanced training in such a discipline. Recently, I have become aware that there are exceptions to this technology undergraduate block. GCAT, of course, is my example. GCAT is the brainchild of Dr. Malcolm Campbell (Davidson College, North Carolina) who wrote and received a NSF grant to learn microarray technology and make it available to other faculty teaching undergraduate laboratories. When I joined GCAT, I gained the ability to overcome the high cost of the technology because Dr. Campbell had arranged for us to purchase yeast microarrays at cost. He also arranged to have the microarrays scanned (since microarray scanners are $50,000 plus and only exist at large research universities and companies). He also arranged for the data to be downloaded onto a CD; all costs are included in the price of the arrays. GCAT members also have access to programs to analyze the data generated. Most importantly, Dr. Campbell set up a website and a List Serve where members could post messages detailing problems they encountered. Solutions to problems were also posted as were suggestions for methods to avoid problems previously encountered. All microarray data from each group is to be posted on a website linked to the GCAT website.

RIT’s Biotechnology program may have been the first in the United States. It is a vibrant and engaging program that attracts large numbers of students to the Biological Sciences department. It is essential that the biotechnology program provide state of the art courses in biotechnology. I believe the microarray course will be such a course.

II. Targeted Learners or Population:

The targeted learners are third and fourth year biotechnology majors. Currently biotechnology majors choose upper division courses from a menu of different courses. I would expect about 20 students to enroll in this course the first time it is offered as a new course. Eventually, the course might offer two laboratory sections and thus accommodate 40 students. The Department of Biological Sciences enrolls 50-70 students in the biotechnology program each year and these students might elect this course in their junior or senior year. Students in the Biology degree program as well as those in the Biochemistry (Chemistry) degree program may also elect to take this course. It is also possible that students enrolled in the Bioinformatics (Biological Sciences) degree program may elect this course. The Bioinformatics program has not been formally approved at RIT, but it will be submitted for approval during the period of the project.

III. Anticipated Impact on Teaching and/or Learning:

This course will allow students to become familiar with microarray technology and the techniques necessary to carry out an analysis using this technology. Such students will be well prepared to enter the job market, attend graduate programs, or develop the
career of their choice. The ability to take state-of-the art courses such as this also helps retain students in the program and contributes to the high retention rate in the COS.

IV. How to Measure Impact, Report Findings, and Share Information with RIT Faculty (and GCAT Faculty):

The success of the course will be judged by student enrollment in the course and by the student evaluations of the course.

Findings will be posted on a website linked to my homepage which is linked to the Department of Biological Sciences homepage. We will also post our results on the GCAT web page. There is also a possibility that I can report on the microarray course at a Gordon conference to be held in 2003. The topic of the conference is teaching undergraduate biology courses. One of my colleagues, Jean Douthwright, is chair of the program committee for this conference. Jean and I have discussed doing a presentation at this prestigious conference.

I feel one of the things I can share with other RIT faculty is the availability of programs outside of RIT which can greatly enrich a faculty member’s expertise. Before coming to RIT, I was more specialized because one needed to be an expert to get grant monies to carry out projects. At RIT there are fewer faculty in my department and college and yet we need to cover the vast field of biological sciences. Biotechnology is also a fast moving field. Keep up or you are soon outdated. How do you broaden your knowledge and keep up? One method is to join groups such as GCAT and work with faculty at other institutions who are building similar courses to yours. You keep what works in your course and consider adding things that work in others’ courses.

V. Rationale for the Project:

The idea for teaching an undergraduate microarray course came from reading a memo about GCAT last November. I immediately wrote back and asked if I could be part of the project. When the answer was yes, I was faced with the problem that my schedule is set for next year and department money is not available to hire adjuncts to allow me release time to work on the project. Thus, a Provost’s Learning Innovation Grant would allow me the resources to get the course ready to run and give my department and me time to think of how to arrange my schedule and organize the details of the course.

The microarray course will be one of several upper level division courses offered to biotechnology and other majors in the COS. Biotechnology majors are required to choose several of these upper division courses to fulfill requirements for the degree. I expect this course will be very popular since microarrays are discussed on the evening news, written about in the newspaper, and spotlighted in journal and trade publications. I have discussed microarrays in my Cell Physiology course and students were very excited about this new technology. Several students asked if they could do microarrays. I originally said “probably not”, but now will invite these students to be part of the development of this new course.
This project is relevant to other faculty since it describes an opportunity for faculty teaching in undergraduate institutions like RIT to collaborate with faculty at other institutions to achieve a common goal. This project also allows me access to Dr. Pat Brown at Stanford University, who pioneered the use of microarrays and directs the Stanford Microarray database. Dr. Brown donated the microarrays to GCAT and the Stanford microarray facility is reading the microarrays and helping us analyze the data. I feel other faculty can build bridges to outside resources like I have done if they realize that such opportunities exist.

I feel I have the relevant experience to direct the microarray project. Even though microarrays are a recent innovation in biology, the individual techniques required for doing microarray analysis have been developed previously. I worked for two semesters in yeast research laboratories and considered doing both my MS and Ph.D. degrees in yeast. So I can grow yeast. I did RNA isolation during one of my postdoctoral experiences. I learned how to do hybridization experiments since I need this for my research projects. Thus, even though I have not yet done a complete microarray analysis, I have the relevant experience to do so. I also have the GCAT connections as well as connections to the microarray facility recently set up at the University of Rochester. Most importantly, I have extensive experience in doing undergraduate laboratories and know how to make such laboratories interesting and productive.

As stated above, microarray analysis is revolutionizing biology. It will be of great benefit to our students and the program to have a course in microarray technology and analysis.

**Timetable:**

I plan to offer the microarray course as an Independent Study course during the Fall, Winter, and Spring Quarters of the 2001/2002 academic year. Students will help to develop various lab modules ranging from growing yeast, isolating RNA, reverse transcribing the RNA into fluorescent-tagged cDNAs, hybridizing the labeled cDNAs to microarrays, and analyzing the data obtained. They will also read and critique published journal papers which use microarray technology. Some students will develop a website for the course and help write the laboratory protocols which will be used in the microarray course which will be taught the 2002/2003 academic year.