Final Report for "Northern Virginia Community College Training for Biotechnology Workers" Award

August 31, 2006 – February 28, 2010

ABSTRACT

The intent of this project was to expand Northern Virginia Community College's capability to offer training to support the Biotechnology Industry in the northern Virginia region. The general goal of this project was to create a College Biotechnology Program; specific goals of the project were to a) design curricula/courses to prepare students to become entry-level lab technicians, b) redesign and equip lab space to better suit the needs of the program, c) develop partnerships with the local industry through outreach and the formation on an advisory board, d) recruit students into the program, and e) provide instructional support for local high school teachers. At the end of the grant period, NOVA has successfully created two new curricula in biotechnology: an Associate of Applied Science (A.A.S.) in Biotechnology (initiated in Fall 2008) and a Career Studies Certificate for Biotechnology Lab Technicians (to be initiated in Fall 2010). These curricula were designed with advice from an external advisory committee which is comprised of representatives from industry, transfer institutions and high school administrators. To date, almost all courses have been designed and piloted; the equipment needed for the courses and the initial supplies were paid for by the grant as was the re-modeling of some lab space to be used for the biotech courses. In order to market the program, the NOVA Biotech Program has also established relationships with the local high schools. Presentations were given at several local high schools and on-site workshops were held for high school students and teachers. As a result, close to 1000 students have attended program open houses, presentations within the high schools, or workshops held in the summer. Over 100 teachers have received information and/or training in biotechnology. These outreach efforts as well as high quality curricula have started to attract a number of students to the program – for example, there are currently 70 students enrolled in the A.A.S. program. The first students in the biotech program are expected to graduate in Spring 2011; already, students enrolled in the biotech program/courses have obtained jobs or internships in several local companies. Our current goal continues to be **to foster the formation of a regional biotech education pipeline into the local industry** which includes the ***recruitment*** of individuals into the NOVA Biotech Program, the ***training*** and graduation of highly-skilled lab technicians, and the ***placement*** of graduates in local biotech industry jobs.

INTRODUCTION

The Biotechnology Industry. The biotech industry includes a diverse group of companies with a common link—the use of living organisms, their parts, or products to enhance our health, environment, and lives (Biotechnology Industry Organization, 2008). In this sector, more than 40,000 businesses are involved in activities such as pharmaceutical research, medical device production, forensics, agriculture, environmental remediation, bioinformatics, and biodefense. In 2004, the President's High Growth Job Training Initiative included biotechnology as one of its fourteen sectors that are projected to add substantial numbers of new jobs to the economy (U.S. Dept of Labor, 2004). Such growth is expected to occur in the Washington D.C. metropolitan region, currently one of the world's largest bioscience clusters. This area houses over 460 biotech companies, as well as a number of government agencies, academic institutions, and professional associations (Greater Washington Initiative, 2007).

Recently, the biotech industry has expanded into northern Virginia where half of Virginia's 180 biotech companies now reside (Virginia Biotechnology Association, 2009). Other important members of the northern Virginia life science community include the Howard Hughes Medical Institute's (HHMI) Janelia Farm research campus, the life science campus of George Mason University (GMU), and government agencies such as the Virginia Department of Forensic Science. According to Martha Schoonmaker from Prince William County's Department of Economic Development, "more

biotech companies are expected to move into this region in the near future". Data from the Virginia Employment Commission also predicts a 30% increase in the number of lab technician positions between 2004 and 2014, over a third of which will require less than a bachelor's degree (Virginia Employment Commission, 2008). Collectively, these data indicate that **the biotech industry will continue to expand in northern Virginia, resulting in an increased need for skilled entry-level workers**.

The role of NOVA in technical education. Northern Virginia Community College (NOVA) is a six-campus community college located in the Virginia suburbs of the Washington, D.C. region. NOVA is the largest higher education institution in Virginia with over 65,000 students enrolled in Fall 2009. As an institution, NOVA is one of the most diverse community colleges in the nation with a student population that is 51% White, 15% Black, 14% Asian, and 12% Hispanic (Office of Institutional Research, 2008). Furthermore, students enrolled at NOVA tend to be from families with low to moderate income and more than half are first generation college attendees. NOVA offers transfer degrees in Science, Computer Science, Information Technology, and Engineering; Associate of Applied Science (A.A.S.) degrees are available in computer science, information technology/security, electronics, engineering, and most recently, biotechnology.

GOALS OF THE CURRENT PROJECT

The general goal of this project was to create a College Biotechnology Program which would serve as an important part of a regional biotech education pipeline (Figure 1). Specific goals of the project were to:

a) design curricula/courses to prepare students to become entry-level lab technicians
b) redesign and equip lab space to better suit the needs of the program
c) develop partnerships with the local industry through outreach and the formation on an advisory board
d) recruit students into the program
e) outreach to high school students/ teachers

OUTCOMES OF THE CURRENT PROJECT

Creation of new biotech curricula. To fill the growing need for skilled entry-level lab technicians, a new biotech program was initiated in 2007 with the use of grant funds. This program currently includes an A.A.S. degree in Biotechnology which was designed to train students in basic laboratory techniques and instrumentation for immediate application in local biotech jobs (see Table 1 for curricula). A career studies certificate in Biotechnology is also currently being considered for initiation in Fall 2010, targeting students who already have a college degree and need re-training and/or are switching careers. These curricula are collectively referred to as the NOVA Biotech Program.

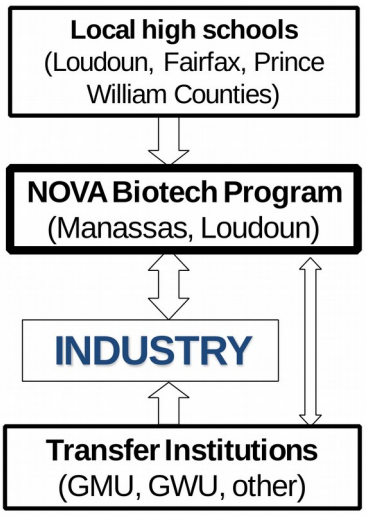


Figure 1. A regional biotech education pipeline

Planning for the new A.A.S. in Biotechnology began in Spring 2007, with significant input provided by NOVA's Biotech Program Advisory Committee. A complete list of members is provided in the supplemental information). This committee consists of career and technical education administrators from local high school districts, biotech faculty at local 4-yr colleges and universities, directors at county Departments of Economic Development, and industry members from a number of biotech companies and research institutions. In the academic year 2007-2008, the A.A.S. in Biotechnology was approved by the Biotech Program Advisory Committee, NOVA, and the State Council on Higher Education in Virginia. A new career studies certificate in Biotechnology is expected to be offered beginning in Fall 2010. In brief, these curricula incorporate science classes, an

introductory biotech lecture and lab course, specialized lab courses in DNA and protein methods, coursework in quality control and quality assurance, and an internship. The student outcomes for the program are:

1. Explain the fundamental scientific concepts in biotechnology.
2. Apply the scientific method including: planning and experiment, collecting data, analyzing and interpreting data.
3. Demonstrate proficiency in standard lab procedures and in the use of basic lab equipment.
4. Identify and follow lab safety procedures.
5. Maintain proper lab documentation according to Good Laboratory Practices (GLP's).
6. Effectively communicate scientific concepts, strategies, and opinions in written and oral formats.
7. Describe the ethical, regulatory, business, and legal aspects of the biotechnology industry
8. Demonstrate professional interpersonal skills and behaviors necessary for working and collaborating in a laboratory environment.

Table 1. Courses in the A.A.S. in Biotechnology

First Year		**1st Semester**	**2nd Semester**	**3rd Semester**
BIO	101 General Biology or BIO 173 Biology for Biotechnology	4		
CHM	111 College Chemistry I	4		
ENG	111 College Composition I	3		
ITE	115 Intro to Computer Applications	3		
SDV	101 Orientation to Biotechnology	1		
BIO	170 Biotechnology Methods		2	
BIO	253 Concepts in Biotechnology		3	
CHM	112 College Chemistry II		4	
MTH	157 Elementary Statistics		4	
BIO	205 General Microbiology			4
[1]	Social Science Elective			3
	Total Credits/Semester	**15**	**13**	**7**

Second Year	**1st Semester**	**2nd Semester**

BIO	206 Cell Biology	4	
[2]	Biotechnology Science Elective	3	
ENG	115 Technical Writing	3	
[3] PED/RPK	Elective	2	
[1]	Social Science Elective	3	
	Biotechnology Applied Science Elective		4
[5]	Biotechnology Experiential Learning Elective		3
BIO	254 Capstone Seminar in Biotechnology		2
[6]	Humanities/Fine Arts Elective		3
[7] SPD	126 Interpersonal Communication		3
	Total Credits/Semester	**15**	**15**

Total credits for the A.A.S. Degree in Biotechnology = 65.

[1] The social science elective may be selected from economics, geography, history, political science, psychology, or sociology (includes anthropology) courses listed on pages 40-41.

[2] Biotechnology elective in the science category may be selected from BIO 256 (General Genetics, 4 cr.), CHM 260 (Introductory Biochemistry, 3 cr.) or MDL 215 (Immunology, 2 cr.) Students who choose MDL 215 must take one additional credit in the Biotechnology Experiential Learning category.

[3] The PED requirement may be met by one of the following options: PED 116, 2 cr.; PED 116, 1 cr. plus a PED activities course, 1 cr.; or PED 116, 1 cr., plus RPK 205, 216, or 225. PED 116 is offered as both a 1-credit and a 2-credit course.

[4] Biotechnology elective in the applied science category may be selected from BIO 251 (Biotechnology I: Protein Research, 4 cr.) or BIO 252 (Biotechnology II: DNA Research, 4 cr.).

[5] Biotechnology electives in the experiential learning category may be selected from BIO 290 (Coordinated Internship), BIO 296 (On-Site Training in Biotechnology), BIO 297 (Cooperative Education), BIO 298 (Seminar and Project), and BIO 299 (Supervised Study). A total of 3 credits in this category is required, from a combination of 1-3 credits in any of these courses.

[6] The humanities/fine arts elective may be chosen from those listed in the college catalog.

[7] Students can also substitute SPD 100, 110, 115, 227 or 229.

Work has also begun to deliver the courses in alternative formats where possible; for example, BIO253: Biotechnology Concepts is now offered on-line and currently has 25 students enrolled in it. The A.A.S. degree currently has 70 students enrolled in it, half of which are in their first or second semester of science courses. The other students are in the process of taking developmental English or math in order to initiate the program. All courses, with the exception of the protein course and the capstone seminar, have been offered.

Re-design and equipping of lab space. The NOVA Biotech Program is based at two campuses, the Manassas Campus (MA) and the Loudoun Campus (LO). In order to develop a biotech program and its associated courses, we had to purchase a significant amount of equipment to outfit the labs at both campuses. A detailed list of equipment ordered is provided in the budget details. A portion of grant funds were also used to re-design current lab space to accommodate small biotech courses. During the grant period, the college has included designated biotech lab space in buildings set to open within the next two years at MA and LO.

Industry outreach. Several companies/research institutions are represented on the Biotech Advisory Committee including Covance Laboratories, HHMI – Janelia Farm, American Type Culture Collection (ATCC), GMU, MediaTech, Bode Technology, Human Genome Sciences, and Rividium. NOVA has also joined the VA Biotechnology Association, the Northern VA Technology Council, and the Loudoun County Science and Technology Cabinet in order to expand its existing network of biotech companies in the area. Since the program began in Fall 2008, students have been placed in internships at the U.S. Geological Survey and in entry-level jobs at MediaTech, Covance Laboratories, and Bode Technology.

Recruitment and high school outreach. In order to foster enrollment in these new curricula, we have begun marketing the program with outreach activities targeting high school students and teachers. Such activities have included presentations at 10 local high schools, two full-day open houses attended by 100 high school juniors and seniors, a 2-day summer workshop on DNA fingerprinting for 20 local high school teachers, and a Biotech Bootcamp for 15 high school teachers new to biotechnology. These activities have been well-received by the attendees. From Fall 2008-Fall 2009, the following data was collected which collectively indicate that outreach activities have led to increased enrollment in the program.

- Design and distribution of 1000 flyers and/or brochures to local high schools, NOVA students, general community
- 1704 visits to the homepage of the Biotech Program Website
- Press releases in 4 local newspapers, including Washington Post
- Visits to 11 local high schools with 900 students attending presentation on NOVA Biotech Program.
- On-site workshops (open houses, CLEAR, etc) = 370 students
- Participation in local community events including Biotech Bonanza for Prince William County
- Enrollment in A.A.S. program
  - Fall 2008 = 23
  - Spring 2009 = 31
  - Fall 2009 = 61
- Enrollment in biotech classes
  - BIO170 (Fall 2008 @ LO): 5 students
  - BIO253 (Fall 2008 @ LO): 6 students
  - BIO170 (Spring 2009 @ MA): 8 students
  - BIO253 (Spring 2009 @ MA): 8 students
  - BIO253 (Fall 2009 @ ELI): 23 students
  - BIO252 (Fall 2009 @ MA): 5 students

- SDV101 (Fall 2009@MA): 10 students

Results indicate that marketing the program through various medias (print, info session, website) corresponds to an increase in enrollment in the program – with 3x as many students enrolled in the program in Fall 2009 than Fall 2008. We expect that the benefit of these marketing techniques will long-term in that the larger community will know about the program and high school teachers can help promote it in their classes.

In terms of outreach to teachers and students, our goal was to increase high school student's and teacher's knowledge in Biotechnology (supporting NOVA's role in community service and our recruitment efforts). The following list shows the activities undertaken for this purpose:

- On-site workshops (open houses, CLEAR, etc) = 370 students
- Workshop run at in-service training day for science teachers in Fairfax County (Fall 2008)
- Presentation made to the science chairs at all of the LO high schools (Fall 2008)
- 2-day summer academy for high school teachers (Summer 2009)
- Specialized workshop in microsatellites (Summer 2008)
- In-class activities run in the local high schools (2 events in Fall 2009)
- List of biotech education resources on-line provided via website

Partnering with other educational institution. As part of the curriculum development process, faculty members from the Biotech Program have collaborated with the other members from the biotechnology educational community. In 2007, faculty members attended a Regional Biomanufacturing Conference, the VA Tech Biotechnology Education Conference; she also was a fellow at the 2008 Bio-Link Annual Conference. We have also worked closely with Montgomery College which has a very successful Biotechnology program and is located in the Maryland suburbs of Washington D.C. Being part of the larger biotech educational community, especially Bio-Link, is essential for incorporating best practices into the grant activities. NOVA's has begun working with local transfer institutions such as George Mason University (GMU) to broaden the educational opportunities for our program graduates.

SUMMARY OF EXPENDITURES

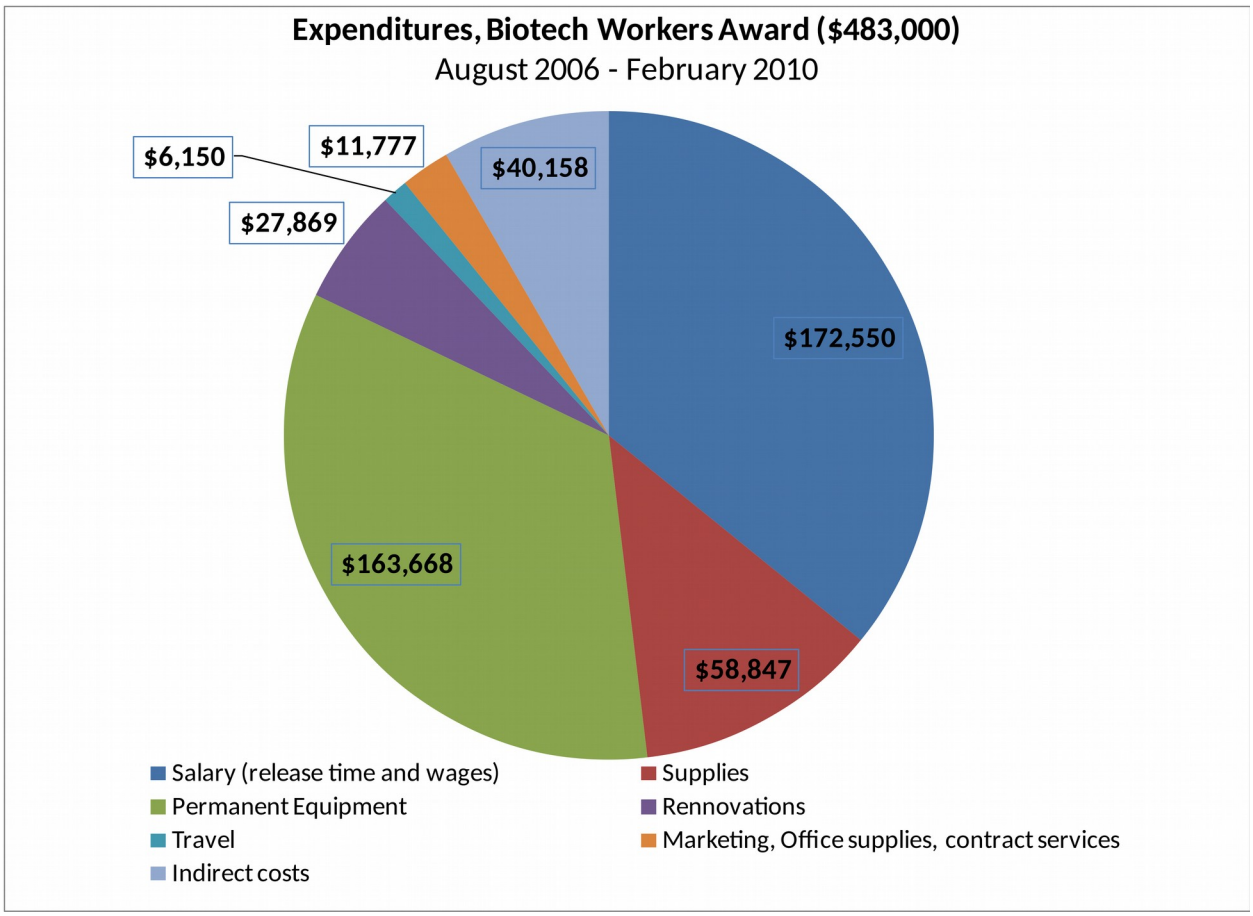
In the following section, an overview of the expenditures is presented (Figure 2). A full financial report will be submitted the accounting office of the College.

Salary. This earmark has supported the work of several faculty, staff, and students. A Biotech Outreach Coordinator has worked 20-hrs/week from October 2007-February 2010; her work has focused on promoting the program in the local high schools. The Biotech Program Head has been paid for reassigned time each semester as well as received a summer stipend to attend conferences, develop curricula, and help run summer outreach programs. Assisting faculty were also given a small amount of reassigned time/stipends for their work in developing new curricula. A 20-hr/week lab technician was employed from Jan 2008-Feb 2010 in order to support the equipment and lab set-up for new biotech courses, help develop new lab exercises, and place orders. Four student workers were also employed for short periods of time to help with biotech-related lab work.

Equipment. A significant proportion of the earmark was spent on the purchase of permanent equipment that is located in the MA and LO labs. Such equipment includes basic lab equipment that can be used in a variety of classes to specialized biotech equipment that is to be utilized in the protein or DNA course. Furthermore, at the end of the grant

period, we purchased a trunk of biotech equipment to support our outreach efforts. This includes equipment that can be lent to partner high schools.

Figure 2. Summary of Expenditures



The equipment purchased during the grant period included:

- Water baths
- Shakers
- Analytical balances
- Assorted glassware
- Centrifuges (large table-top and microcentrifuges)
- DNA electrophoresis equipment (power supplies, gel boxes, etc)
- Protein electrophoresis equipment
- Vacuum apparatus
- Vortex/mixers
- Turntables
- Pipettes (macro and micro-sized, single and multi-channel)
- Freezers (including -80C)
- Fermentation system
- Gel documentation system and transilluminator
- Camera system for microscope
- Inverted microscopes
- Incubators
- Microplate readers
- Real-time PCR system
- Thermocycler
- Western blot system

Supplies: An extensive amount of supplies were ordered for the purposes of developing and piloting classes and for running them during the grant period. Lab-based courses, particularly those in biotechnology (DNA and protein analysis,

etc) are very expensive in terms of expendable supplies and reagents. For example, it is not uncommon to spend $500 on a single restriction enzyme. Specifically, in order to run the Biotech Methods course for one section, the supplies costs approximately $10,000. Subsequent sections cost less although still can cost almost $5000 to run. Because this is a new program for the college and the courses were piloted with low numbers of enrolled students, the college was unable to pay for these supplies. After the grant period, the college has committed toward funding these high cost classes. Supplies were also necessary for our outreach efforts which included running samples on the College's DNA analyzer and having students complete pre-made commercial exercises.

Rennovations. As was mentioned previously, a portion of the grant funds was used to renovate current lab space at the MA Campus. This included the re-design of a small laboratory prep area, the installation of new cabinets and furniture, and the re-wiring of the space for new electrical demands. Through this re-design, the prep area is now fully functional and contains all of our large biotech equipment (see above). This space is now suitable to run small biotech courses as well; for example, our DNA Methods course was run in this space in Fall 2009.

Travel. During the grant period, the project manager and biotech faculty were funded to travel of several biotech conferences which included: Virginia Tech Biotechnology Education Conference at the Fralin Center, Bio-Link (a national consortia of community college biotech educators), and the Mid-Atlantic BIO conference. Attendance at conferences was instrumental in curriculum development and in making connections with the local industry.

Marketing materials. A key grant activity was the marketing of the program to the general public and specifically to students at local high schools. A small proportion of grant funds was used to design and purchase marketing materials including handouts, magnets, and small calendars. Marketing funds were also used to buy refreshments for our outreach events such as our open houses.

Indirect costs. Indirect costs were charged as 25.3% of the personnel costs.

SUMMARY AND CONCLUSIONS

The earmark administered by the DOE has enabled NOVA to begin the establishment of a biotech educational pipeline in northern Virginia where high school students can be exposed to biotech applications and techniques, enroll in and graduate from NOVA's Biotech Program, and then enter the local industry as an entry-level lab technician and/or matriculate at a transfer institution. Once enrolled in NOVA's Biotech Program, students will learn lab techniques and instrumentation in small classes under the advisement/instruction of a Ph.D. scientist who is well connected to the local academic community and the biotech industry. They can then get job placement assistance into a high-demand, well-paying job in a company that may then pay for them to pursue a B.S. degree at a transfer institution that will accept all of their A.A.S. coursework. The presence of this educational pipeline is expected to increase the number of skilled lab technicians. This will help to meet the growing workforce demand of the local biotech industry which, despite challenging economic conditions, continues to expand. The first graduates of the program are expected in Spring 2011.

In addition to the creation of an education pipeline, another goal of the Biotech Program is to promote biotechnology as a career option and to expand educational access in this field to students who have historically been excluded due to their past academic achievement, financial need, or cultural diversity. Not only is NOVA one of the most diverse community colleges in the country, but it is an affordable option for students who may not be able to afford a university immediately upon high school graduation. By offering such students, often times who are minorities, the opportunity to obtain technical training and find a high-paying job in the local economy, the grant activities are expected to lay the foundation for the recruitment of students who do not traditionally enroll in college or technical programs. Our efforts to recruit minorities are supported by the local Hispanic community, including a CEO of a bioinformatics

company who is donating full scholarships to academically-prepared minorities entering the program. Because many of our industry partners are prepared to hire program graduates and then pay for their bachelor's degree, program graduates will also have expanded educational access and promotion potential. Articulation agreements with local transfer institutions will make this a seamless transition for these students. We believe that these efforts will increase enrollment of minorities and economically disadvantaged students into the biotech educational pipeline but also serve as a model for other community colleges in culturally diverse areas.

The College Biotech Program also promotes biotechnology to high school students and teachers. Because biotechnology is a relatively new field, perceived by some to be irrelevant and/or highly technical, vast majority of high school students lack scientific literacy and could not accurately define biotechnology or name one local biotech company. In addition to enhancing enrollment in the NOVA Biotech Program, we expect that outreach activities for high school students have resulted in hundreds of high school students learning about biotechnology. The training of teachers as part of this grant will also lead to biotechnology being more integrated into the high school curriculum. Both of these are expected to result in more students majoring in biology/ biotechnology at all colleges and universities. Because current trends indicate that the student interest in science is flat or declining, our work will serve an important role in recruiting future scientists, whose training is essential to U.S. economic growth and national security (National Science Board, 2003).

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