

# NASA and Biotechnology – Professional Development for Secondary Teachers

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## Abstract

An integral part of enhancing science education is training teachers in current content and techniques, and biotechnology is one of the technologies that will be needed to maintain living systems in space. The BioPharmaceutical Technology Center Institute (BTC Institute) offered two graduate education courses in biotechnology for teachers during summer 2012. Each weeklong course was held at the BioPharmaceutical Technology Center. *Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* provided teachers with training, background and curriculum materials including information about NASA and biotechnology. Teachers of a wide variety of subjects with varied levels of teaching experience were active participants in this lab-based learning. They are now prepared to provide similar opportunities for their students.

## Introduction

*Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* are week long summer courses that were offered by the Biotechnology Technology Center Institute (BTC Institute) July 16-20 and July 23-27, 2012 respectively. The primary goal of *Biotechnology: The Basics* and *Biotechnology: Beyond the Basics*, is to provide middle school and high school teachers with the training essential to implementation of a laboratory-based biotechnology curriculum. This goal served as the guide in designing and implementing each activity, as well as in structuring each course. Both courses were offered for graduate education credits through Viterbo University and Edgewood College. All three course instructors are experienced teachers of biotechnology at the secondary level.

Three objectives of the National Space Grant Program are to:

- “Promote a strong science, technology, engineering, and mathematics [STEM] education base from elementary through secondary levels while preparing teachers in these grade levels to become more effective at improving student academic outcomes.”

*Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* help prepare teachers to provide “a strong STEM education base” utilizing current content and techniques. Classroom implementation of these content and techniques will enrich student learning which can “improve student academic outcomes”.

The BTC Institute is pleased to acknowledge the Wisconsin Space Grant Consortium (Aerospace Outreach Program) for their financial support of 9 teacher scholarships for these courses in 2012. In addition, the 2012 courses received support for 2 teacher scholarships from FOTODYNE, Inc.

- “Encourage interdisciplinary training, research and public service programs related to aerospace.”

The need for quality STEM education training extends throughout many scientific disciplines, and as plans are made for humans to travel and someday live in space, biotechnology joins other technologies to support the “public service programs related to aerospace. Often students and teachers in the life sciences do not fully realize how biotechnology relates to NASA. One of the objectives for both courses is to highlight how biotechnology is and will be used in space exploration.

- “Recruit and train U.S. citizens, especially women, underrepresented minorities, and persons with disabilities, for careers in aerospace science and technology”.

Enthusiastic well-trained STEM teachers are key to recruiting diverse future STEM professionals in “aerospace science and technology”. Making connections between biotechnology and NASA increases the pool of teachers and students who will help meet this objective since it also brings in life science teachers and the students that they teach. (National Space Grant College and Fellowship Program [Space Grant] 2010-2014).

NASA Education Priorities, Current Areas of Emphasis for Space Grant projects include: “Authentic, hands-on student experiences in science and engineering disciplines –the incorporation of active participation by students in hands-on learning or practice with experiences rooted in NASA-related, STEM-focused questions and issues; the incorporation of real-life problem-solving and needs as the context for activities.” Both courses included “real-life” examples of how biotechnology is utilized by NASA, and “hands-on learning” of fundamental biotechnology techniques is the core of the curriculum. In addition, one of the requirements for teachers receiving a WSGC scholarship for *Biotechnology: The Basics* or *Biotechnology: Beyond the Basics* was to “submit a 2-3 page summary report to the BTC Institute, at the end of the 2012 or 2013 semester in which they implement discussion of NASA utilization of Biotechnology.” Teachers who took the courses in 2011 were required to do this and several examples of how teachers implemented “a discussion of NASA utilization of Biotechnology” were featured to help 2012 teacher participants include this in their upcoming classes.

### **Program Details**

Both *Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* were one-week courses offered in summer 2012. Representing rural, urban, and suburban school districts, the attendees were teachers of a variety of subjects, including: middle school science, biology, biotechnology, agriculture, and chemistry. Currently there is a strong encouragement from the state of Wisconsin for agricultural educators to receive more science training. They are teaching many of the Biotechnology courses throughout the state, and over one-half of our attendees were agriculture teachers.

Most participants are high school teachers in Wisconsin, but two are high school teachers in Illinois, one is a junior high school teacher, and many of the Agriculture teachers also teach middle school courses in addition to their high school courses. *Biotechnology: The Basics* 2012 had 8 attendees (5 women & 3 men) and *Biotechnology: Beyond the Basics* 2012 had 7 attendees

(4 women & 3 men), 3 of the attendees took both courses. Class participants included teachers who had no previous training in biotechnology, as well as very experienced secondary teachers looking to update their knowledge of scientific content and techniques. Some of the teachers currently teach an independent biotechnology course; others incorporate biotechnology curricula within other life science, chemistry or agriculture classes. Several teachers were looking for information to help them design and implement a biotechnology course for the first time.

Table 1: Participants in *Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* Summer 2012

<b>Teacher Course</b>	<b>Total Participants</b>	<b>High School Science Teachers</b>	<b>Agriculture Teachers - Who often teach both high school and middle school</b>	<b>Junior High School Science Teachers</b>
<i>Biotechnology: The Basics</i> 2012	8	2	5	1
<i>Biotechnology: Beyond The Basics</i> 2012	7	4	3	0

The number of attendees for the 2012 courses was largely due to scholarship funding provided by a Wisconsin Space Grant Consortium-Aerospace Outreach Program grant which covered scholarships for 9 teachers, and 2 Fotodyne, Inc. scholarships. Professional development funding is increasingly difficult for teachers to obtain, and the BTC Institute and the teachers who took the courses are very grateful for the scholarships.

Barbara Bielec (K-12 Program Director, BTC Institute), Peter Kritsch (Teacher, Oregon High School), and Kathryn Eilert (Teacher, Middleton-Cross Plains High School) worked together to plan and implement the courses. All three are experienced teachers of biotechnology at the secondary level. The BTC Institute course fee was \$500 in 2012. Both courses were offered for graduate education credits through Viterbo University (3 graduate credits for \$330) and Edgewood College (1-3 graduate credits for \$150/credit).

Topics and laboratory activities for *Biotechnology: The Basics* included:

- Use of Micropipettes
- Agarose Gel Electrophoresis
- DNA Extraction
- Restriction Enzyme Digestion
- Polymerase Chain Reaction
- Bacterial Transformation
- Bioethics – use of Case Studies

- Genetic Counseling
- Biotechnology and NASA
- Stem Cells
- BioFuels and the Great Lakes Bioenergy Research Center
- Careers and Training in Biotechnology

Topics and laboratory activities for *Biotechnology: Beyond the Basics* included:

- Polymerase Chain Reaction and Transformation of the PTC gene
- Genetic Identity Testing using Short Tandem Repeats (STRs)
- Microarrays
- Science and Social Media
- Protein Purification and Detection
- Immunology- Antibody isolation and detection
- Bioinformatics and Phylogeny
- Biotechnology and NASA
- Bioprospecting and the Great Lakes Bioenergy Research Center
- Careers and Training in Biotechnology

Implementation was consistently emphasized. How would teachers apply what they learned in their own classrooms? Resources included:

- A comprehensive course binder for each teacher
- Laboratory protocols, classroom activities and power point presentations on a flash drive for each teacher
- Daily discussion and review of course topics and resources
- Discussion of funding and equipment sources and tips for successful grant writing

Each day teachers wrote a reflection detailing how they would integrate material into their curriculum and the challenges that they might face, including the resources they would need. These reflections were discussed the next day with the entire group. Additionally, as a final project, each teacher had to design and present a detailed and personalized curricular unit (lesson plan) for teaching the content learned.

## Results

Course evaluations were extremely positive. For *Biotechnology: the Basics* teachers wrote:

- “Keep up this wonderful opportunity for students and teachers”.
- “Info. was delivered wonderfully. Decent amount of time – great resources etc.”
- “All [workshops] had wonderful applications to use- especially to give students examples of where the field of biotech. is used today”.
- “Great Program – Thank you! I really enjoyed the week.”
- “Really appreciate all the sharing of practical materials!”
- “I can honestly think of nothing to improve it [the course]. It exceeded my expectations”.

For *Biotechnology: Beyond the Basics*, teachers wrote:

- “The course was presented in a very teacher friendly way, it was a very useful week....Great workshop!”

- “Thanks for all the resources.”
- “..loved it that I could do 3 credits in a week.”
- “This was a great course! I can’t wait for the next one”.
- “This course was what I wanted and needed”.

Course evaluations also offered suggestions to improve the courses:

- “share a time line of [a] course would be beneficial (sample course outline)”
- “lab write-up techniques – k-12 lab notebooks or just HS lab notebook”
- “ a little more of answering the ‘why’ from an ag perspective”
- “organize each lab with a: what I need, where can I get, kits for each...but seriously this is not a big deal”
- “Lab details could be more emphasized”
- “addressing more alternative ways some of the labs could be ran if tight supplies”
- “ a little more review on what we did the day before ...but I also see this as something I have to spend some time with”
- “I would love more of an in depth explanation of the labs and how they connect to the curriculum for implementation”

Course evaluations and daily reflections are used to improve courses year to year, as well as to address questions and concerns throughout the course. Next year several of the suggestions will be incorporated, including providing sample biotechnology course outlines.

In 2012 one of the requirements to receive a Wisconsin Space Grant Consortium scholarship was to: “Submit a 2-3 page summary report to the BTC Institute, at the end of the 2012 or 2013 semester in which they implement discussion of NASA utilization of Biotechnology. This report should include: description of how a discussion of NASA utilization of Biotechnology was implemented, description and demographics of the course(s) in which the discussion took place, and student feedback on the discussion”. We are looking forward to receiving these reports and learning how teachers use NASA research as a way to demonstrate the relevance of biotechnology content and techniques. We will incorporate the information we receive from teachers about their inclusion of NASA & Biotechnology content in future courses as well.

For both courses, teacher participants were recruited through direct contact at the BTC Institute’s Biotechnology Field Trip Program, at the Wisconsin Society of Science Teachers (WSST) conference and the National Science Teachers Association (NSTA) conference; an electronic mailing to the BTC Institute’s teacher list, the Wisconsin Dept. of Public Instruction (DPI) Science and Agriculture teacher lists, the Wisconsin Association of Agriculture Educators (WAAE) electronic network, and the Illinois Science Teachers Association (ISTA); posting in the WSST newsletter (print and online) and *Science Matters* (NSTA Wisconsin) digital newsletter; electronic posting on the Wisconsin Educators Association Council (WEAC) website the Education Communication Board (ECB) website and the Wisconsin Association of Environmental Education (WAE); emails sent to Cooperative Educational Service Agencies (CESAs) throughout Wisconsin and others; direct recommendation from UW-River Falls Agriculture Education Professor Timothy Buttles; and course listings in the Viterbo University and Edgewood College summer catalogs.

According to data collected on the course evaluations, attendees found out about the course in a variety of ways that are summarized in the following table. The results speak to the strength of the formal and informal networks of Wisconsin agriculture teachers which are reflected in 47% of the responses (7/15), as well as to direct recommendation from another teacher or previous experience with other BTC Institute programs –73% (11/15) of the responses.

Table 2: How Participants in *Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* Summer 2012 Learned About BTC Institute Biotechnology Courses.

<b>How Participants Learned About BTC Institute Biotechnology Courses</b>	<b>Number of Responses (in order)</b>
Other Agriculture teachers and the Wisconsin Association of Agricultural Educators (WAAE) network	3
From another teacher	3
WAAE List Serv or Ag. Education DPI List Serv	2
Dr. Tim Buttles UW-River Falls Ag. Ed. Professor	2
Took previous BTC Institute course	2
From people who have worked with BTCI in the past	1
Wisconsin Society of Science Teachers (WSST)	1
Picked up a brochure at NSTA conference (Indianapolis)	1
<b>Total Responses</b>	<b>15</b>

## Conclusion

The enthusiasm demonstrated by our attendees is always inspiring. It consistently and clearly demonstrates the need for high quality professional development opportunities that have immediate relevance to the classroom. As stated by the National Science Board/National Science Foundation (NSB/NSF) in A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System: “The United States possessed the most innovative, technologically capable economy in the world, and yet its science, technology, engineering, and mathematics (STEM) education system is failing to ensure that *all* American students receive the skills and knowledge required for success in the 21<sup>st</sup> century workforce. The Nation faces two central challenges to constructing a strong, coordinated education system: Ensuring coherence in STEM learning, and Ensuring an adequate supply of well-prepared and highly effective STEM teachers.”

We are committed to offering quality professional development in STEM for teachers so that their students receive the STEM skills and knowledge needed for future success, and we plan to offer both biotechnology courses in summer 2013. We will continue to seek grant opportunities and new partnerships that will enable us to fund teacher scholarships and provide teachers with much-needed resources. As always, we will utilize previous course evaluations to improve our courses.

The support provided by the Wisconsin Space Grant Consortium to design and implement these courses is greatly appreciated. The donations of instructor time and materials from Fotodyne,

Promega, the National Evolutionary Synthesis Center (NESCent), Meriter Hospital, Madison Area Technical College and the Great Lakes Bioenergy Research Center are also key to our success. These partnerships, along with the options to receive graduate education credits through Viterbo University and Edgewood College, ensure the continuation of these essential opportunities for professional development.

## **References**

1. National Space Grant College and Fellowship Program (Space Grant) 2010-2014. National Aeronautics and Space Administration Office of Education FY 2010 NASA Training Grant Announcement. Release Date: 30 November 2009. [http://www.nasa.gov/pdf/418826main\\_Space%20Grant%202010%20Solicitation%20Rev%20B\[1\].pdf](http://www.nasa.gov/pdf/418826main_Space%20Grant%202010%20Solicitation%20Rev%20B[1].pdf)
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