

# Biotechnology Teacher Training

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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 2011. Each weeklong course was held at the BioPharmaceutical Technology Center. *Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* were designed and presented to provide teachers with training, background and curriculum materials (including information about NASA and biotechnology), so that they may implement hands-on biotechnology in their classrooms. Teachers of a wide variety of subjects with varied levels of experience were active participants in lab-based training.

## 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) in summer 2011. 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.

The NASA Directorate for Space Operations is to: “Extend the duration and boundaries of human space flight to create new opportunities for exploration and discovery.”[1] NASA wisely recognizes the need for training throughout many scientific disciplines, and as plans are made for humans to travel and someday live in space, biotechnology joins other technologies to support these efforts. Often students and teachers in the life sciences do not fully realize how biotechnology relates to this directorate of NASA. Another goal of this project is to highlight how biotechnology is and will be used in space exploration. Biotechnology, along with other Science, Technology, Engineering and Math training is needed to help the secondary teachers who directly influence the Science, Technology, Engineering and Math (STEM) professionals of tomorrow.

The BTC Institute is pleased to acknowledge the Wisconsin Space Grant Consortium (Aerospace Outreach Program) for their financial support of 15 teacher scholarships for these courses in 2011. In addition, the 2011 courses received support for 10 teacher scholarships from the Wolbachia Project, a Howard Hughes Medical Institute Precollege Science Education Initiative sponsored by The Marine Biological Laboratory.

## Program Details

Both *Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* were offered in summer 2011. Representing rural, urban, and suburban school districts, the attendees were teachers of a variety of subjects, including: middle school science, biology, biotechnology, genetics, agriculture, environmental science, anatomy and physiology, business, forensics and science outreach. 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 about one-third of our attendees were agriculture teachers.

Most participants (18/26) are high school teachers in Wisconsin, but one is a high school teacher in Illinois, one is a high school teacher in Indiana, four are middle school teachers (including one who teaches in Illinois), and two are science outreach educators (one from Wisconsin and one from South Korea). *Biotechnology: The Basics* 2011 had 18 attendees (12 women & 6 men) and *Biotechnology: Beyond the Basics* 2011 had 8 attendees (all women). As evidence of how teachers value these courses, 4 of the teachers took one of the courses previously in 2010, and several 2011 *Biotechnology: The Basics* attendees made inquiries about registering for *Biotechnology: Beyond the Basics* in 2012. 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 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 2011

Teacher Course	Total Participants	High School Science Teachers	Agriculture Teachers	Middle School Science Teachers	Science Outreach Educator
Biotechnology: The Basics 2011	18	6	7	4	1
Biotechnology: Beyond The Basics 2011	8	6	1	0	1

The healthy number of attendees for the 2011 courses was due to funding provided by a Wisconsin Space Grant Consortium-Aerospace Outreach Program grant which covered course fees for 15 teachers, and a Wolbachia Project grant which covered course fees for 10 teachers. 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 2011. Both courses were offered for graduate education credits through Viterbo University (3 graduate credits for \$270) and Edgewood College (1-3 graduate credits for \$150/credit).

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

- DNA Extraction
- Agarose Gel Electrophoresis
- Restriction Enzyme Digestion
- Polymerase Chain Reaction
- Bacterial Transformation
- Bioethics – use of Case Studies
- Genetic Counseling
- Developing Integrated Lab Activities using the Wolbachia Project
- Biotechnology and NASA

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

- BioFuels and the Great Lakes Bioenergy Research Center
- Microarrays
- Bioethics - use of Case Studies
- Stem Cell Research - current issues, how to address in the classroom
- Genetic Identity Testing using Short Tandem Repeats (STRs)
- Protein Purification and Detection
- Immunology- Antibody isolation and detection
- Epigenetics
- Developing Integrated Lab Activities using the Wolbachia Project
- Troubleshooting Experiments
- Biotechnology and NASA

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
- Special discounts and offers from Fisher Science Education, Promega, and Fotodyne, Inc.
- Resources from the Wolbachia Project, the Great Lakes Bioenergy Research Center, WiCell, and the Fotodyne/BTC Institute Equipment Loan Program
- Daily discussion and review of course topics
- Discussion of funding 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:

- “The course was well organized and much appreciated....This has to be one of the BEST hands on courses that I have taken in my 24 years of teaching- I have materials to take back and implement immediately.”
- “This was, by far, the best training/class I have taken since exiting college. I am so excited to finally do this in class. The two instructors...are absolutely top shelf teachers. Please do everything to keep them.”
- “I can’t tell you how wonderful this class was! It was very helpful & eye opening. I had biotech all around me & didn’t even know it!! Great class, great teachers, great information – best graduate class.”
- “At 50 years old, I went from being extremely uneducated to now possessing some level of comfort in genes, DNA, etc.”
- “I was not sure about taking this course because I thought I would not understand it. I realized on Monday already I was wrong. This was a great week and I’m excited about Biotechnology.”
- “I really like the set-up of this course. It is just the right amount of lecture and lab.”
- “I have already told other teachers to take it [the class] and am planning to block out a week for next year’s class.”

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

- “Wonderful week! I learned so so [sic] much!!! I so appreciate all of the support”.
- “The presenters were great! Very knowledgeable & enthusiastic. I am amazed by all that we did.”
- “I appreciated the variety of topics covered and the flexibility of the instructors/presenters.”
- Excellent Group/Instructors/Facilities & Work.”

Course evaluations also offered suggestions to improve the courses:

- “Have a list of materials + catalogue #s of costs for materials for each section.”
- “Take time to absorb/reflect more often.”
- “I’m still searching for an activity to introduce my students to BLASTs...”
- “I would formally have a Wiki or twitter or web page for classes & a place for us to continue these discussions as we implement and try these things in our classroom.” (Note: one of the Basics course participants did start a Wiki to continue biotechnology exploration among the teachers).
- “Write up [a list] of career, education, money, etc.”
- “I would explain the real life references first, then go to trying to figure out and the inquiry...a list of vocab to brush up on before the class.”
- “Recommended readings ahead of time.”
- “I would add lessons that could be modified for the middle school level.”

- “Give a better preview/background information about the Wolbachia Project and its effects on humans & insects.”
- “Overall I would not change anything! A few of the labs that we did would have ‘easier’ to understand, if we knew the process that was going to happen before we went into the lab.”

For both courses, teacher participants were recruited through an electronic mailing to the BTC Institute’s teacher list; posting in the Wisconsin Society of Science Teachers (WSST) newsletter (print and online); electronic posting and email from the Wisconsin Educators Association Council (WEAC), the Wisconsin Dept. of Public Instruction (DPI), and the Illinois Science Teachers Association (ISTA); posting on the Wisconsin Science Network (WSN) and the Education Communication Board (ECB); flyers distributed at WSST and the National Association of Biology Teachers (NABT) ) conferences; email from the Wisconsin Association of Agriculture Educators (WAAE) electronic network; direct contact through the BTC Institute’s Biotechnology Field Trip Program and at the Wisconsin STEM Summit; 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 38% of the responses (9/24), as well as to direct contact and experience with other BTC Institute programs – also 38% (9/24) of the responses.

Table 2: How Participants in *Biotechnology: The Basics* and *Biotechnology: Beyond the Basics* Summer 2011 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 WAAE network	5
BTC Institute direct contact (field trip)	5
BTC Institute email contact	3
BTC Institute direct contact at a conference or meeting	3
Ag. Education DPI List Serv	2
Dr. Tim Buttles UW-River Falls Ag. Ed. Professor	2
From a school district science coordinator/dept. chair	2
From another teacher	1
WSST website	1
Web page	1
Took previous BTC Institute course	1
<b>Total Responses</b>	<b>24</b>

## Conclusion

The enthusiasm demonstrated by our attendees is always inspiring. It consistently and clearly demonstrates the need for high quality graduate education courses that have immediate relevance to the classroom. As stated in a National Science Teachers Association (NSTA) Position Statement: "To be prepared for the 21st century it is critical that all students have sufficient knowledge of and skills in science. Studies suggest that high-quality teaching can make a significant difference in student learning...a high-quality science teacher workforce requires meaningful, ongoing professional development." [2] We plan to offer both courses in summer 2012, and are seeking grant opportunities that will enable us to fund teacher scholarships. As always, we will utilize previous course evaluations to improve our courses.

In 2011 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 2011 or 2012 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.

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, WiCell, Promega, Fisher Science Education, Great Lakes Bioenergy Research, and the Wolbachia Project 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. NASA Directorate for Space Operations, <http://education.nasa.gov/about/nasaent/>, 2010
2. NSTA Position Statement, Professional Development in Science Education, <http://www.nsta.org/about/positions/profdev.aspx>, adopted May, 2006