

The BIOMAN Journal

Premier Life Sciences Facility Hosts Annual BIOMAN Conference

Sonia Wallman, founding principal investigator of the Northeast Biomanufacturing Center and Collaborative (NBC2), welcomed 41 educators to the four-day BIOMAN Conference at the Indiana Center for Life Sciences, a facility operated by Ivy Tech Community College in Bloomington, Indiana.

"BIOMAN professional development conferences are known for having keynote speakers who provide both up-to-date and historical perspectives on bioproduct development, production, and analysis, along with intensive hands-on labs with take-home SOPs for just-in-time implementation.

"This year's BIOMAN continues these effective practices. It features keynotes and new hands-on material in aseptic formulation, fill, and finish from Sengyong Lee, chair of biotechnology at Ivy Tech Community College Bloomington, and his biomanufacturing partners. The new hands-on labs that Lee created with his partners complement new textbook chapters," Wallman said during her opening remarks. She pointed out that all BIOMAN materials are available on the NBC2 website at www.biomanufacturing.org. The July 13 to 16 conference was the tenth annual BIOMAN.

Kirk Barnes, dean of Ivy Tech Bloomington, pointed out that the Indiana Center for Life Sciences opened in 2009 thanks to the college's collaboration with the Bloomington Life Sciences Partnership and voters' approval of a \$5 million bond issue.

Ivy Tech Bloomington pays the county \$1 per year rent for the facility that it operates; the county pays the community college \$1 for the use of the land. At the end of this 20-year agreement, Monroe County will donate the building to Ivy Tech Bloomington. The college campus is on an adjacent parcel of land. The facility is also near Cook Pharmica, Cook Medical, Baxter BioPharma Solutions, and several start-up bioscience companies.

Cook Medical, and its subsidiary Cook Pharmica, and the Eli Lilly Foundation supported the college's addition of an



Community college and high school educators convene for the 10th Annual NBC2 BIOMAN Conference at the Indiana Center for Life Sciences, operated by Ivy Tech Community College in Bloomington, Indiana.

18-credit regulatory concentration certificate. Ivy Tech Bloomington also offers certificates in biopharmaceutical manufacturing, quality control, and research and development. It has both associate of applied science and associate of science degrees in biotechnology.

"It's been really a great partnership," Lee said. He explained that the center's laboratories, classrooms, and 5,000 square foot training suite are available for free customized training of new and incumbent biotechnicians, as well as for the college's allied health and biotechnology students' courses.



BIOMAN participants gather for a keynote presentation to kick off a day of hands-on workshops and interactive sessions.

BIOMAN Helps Citrus College Instructor Start Program

"I really was at square zero," Barbara Juncosa says of her initial planning in 2014 for a biotechnology certificate program at Citrus College in Glendora, California. When she attended her first BIOMAN conference in 2014, she was still trying to figure out basic program organization.

During BIOMAN's hands-on workshops she took notes and talked with other participants about how their programs are organized, what they did to recruit students, and where their graduates work.

After the meeting Jennifer Imbesi, NBC2 program manager, provided her with a course plan. Juncosa also emailed questions to Maggie Bryans, co-principal investigator of NBC2 and assistant professor of biotechnology at Montgomery County Community College in Blue Bell, Pennsylvania. NBC2 personnel "always have been very helpful," Juncosa said.

In fall 2014, during just her third year of teaching microbiology for allied health, Juncosa developed course outlines and plans for basic lab experiments and biomanufacturing instrumentation using NBC2 materials. NBC2's *Biopharmaceutical Manufacturing Industry Skill Standards* served as the foundation for her course objectives. "It just provided a backbone of skills and competency," she said.

Once she had college and other approvals of the certificate, Juncosa began recruiting students. She used a STEM grant to produce a video with personnel at Grifols and Prolacta Bioscience, Inc. In May 2015 she held a career panel where five technicians explained their jobs to 130 students. The technicians work in pharmaceutical manufacturing, medical device manufacturing, quality control microbiology, microbrewing, and laboratory equipment manufacturing.

At BIOMAN 2015 her goal was to learn as much as possible about biotech instruments and effective pedagogies for teaching with them. She also took extensive notes about biotech course activities and assessments.

As she left her second BIOMAN on a first-name basis with many more biotech faculty, Juncosa was a little nervous about how many students would sign up for the first course of the new certificate program. But Citrus College's dean had committed to offer the program even if enrollment was low.

The next week Juncosa emailed good news to NBC2: all 16 slots in Biotechnology I: Basic Lab Skills and Documentation were filled in the first week that enrollment was open and there is a waiting list for the course.

BIOMAN Influences Teaching Techniques and Program

Early in the summer of 2015 Alphonse Mendy took a chance and contacted Montgomery County Community College (MCCC), the lead institution for NBC2, to see if he could talk with the staff and tour the facilities in Blue Bell, Pennsylvania, while traveling in the Northeast

During his visit Mendy shared his hopes of starting a biomanufacturing program at Kansas City Kansas Community College with Maggie Bryans, assistant professor of biotechnology at MCCC and co-principal investigator of NBC2. She suggested he attend BIOMAN.

"It was my stroke of luck that I stopped at Montgomery County Community College," Mendy said, happily reporting on the fourth day at BIOMAN that he had learned a "ton of information."

As a result Mendy plans to change aspects of his pedagogy and his entire approach to the expansion of biomanufacturing at his college. He teaches introductory biomanufacturing and biotechnology courses as well as anatomy, physiology, and microbiology, primarily to allied health students.

Barbara Bielska's process for teaching the enzyme-linked immunosorbent assay (ELISA) impressed him. "The way I was taught [at BIOMAN] is different than how I was teaching the students. It is something I will implement right away," he said. Bielska is a biotechnology professor and program coordinator at Northampton Community College in Bethlehem, Pennsylvania.

"I learned about the biomanufacturing process from the presentation by Dr. Lee with Cook Pharmica, and I will share that information with my department. And I will also talk about the process of starting this whole thing, that it is very integral to involve the biomanufacturing companies so they are part of the process," he said.

Mendy noted that Sonia Wallman, NBC2 founding principal investigator, gave him practical advice and convinced him to seek industry input now to shape the new program's content. He had previously planned to obtain a grant, set up labs, and then unveil the program to the international biotech companies with facilities near campus.

"What I've learned here is that it is very important to have industry come in and be part of the process," he said.

Educators Learn to Express, Purify, and Analyze Taq Polymerase

The Beginner Track hands-on workshop on the Expression and Purification of Thermophilic DNA Polymerases provided educators with multiple resources to incorporate a new curriculum module into classroom lectures and laboratories.

NBC2 partner Thomas Burkett began with a brief history of biomanufacturing, complete with examples of laboratory research being transformed to large scale manufacturing of bioproducts. Burkett is a biology professor at the Community College of Baltimore County and in his off time leads a biotech maker space. Maker spaces are workspaces operated by individuals with shared interests.

Burkett developed NBC2's standard operating procedures (SOPs) for the *Escherichia coli*-Taq polymerase core production system. The SOPs are used throughout the US to teach biotechnology research, development, production, molecular biology, fermentation and protein purification, and quality control.

During the three days of four-hour lab sessions at BIOMAN, Burkett guided educators through the processes to express, purify and analyze Taq polymerase from *Thermus aquaticus* genomic DNA. He also offered tips on how to use the laboratory activities in introductory biomanufacturing and advanced molecular courses.

He described the lessons as an excellent example for showing students the economics of biomanufacturing because recombinant Taq polymerase purified from *E. coli* is one of the most important enzymes used in the biotechnology industry. Taq is primarily utilized in the polymerase chain reaction (PCR) to amplify a DNA sequence.

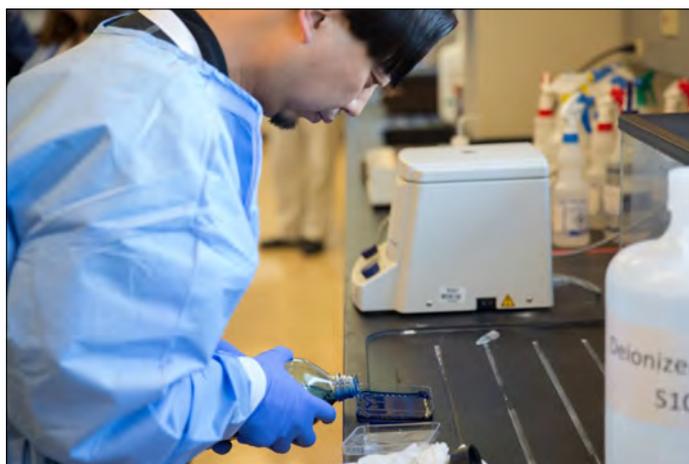
He pointed out that the Taq polymerase expressed and purified during the lessons can be used in students' PCR experiments and costs less than purchasing it from commercial suppliers.



Ann Wegman reviews an NBC2 SOP for the expression purification of Taq polymerase.



Thomas Burkett examines a sample with Mabel Jackson.



Anson Lui stains an SDS-PAGE gel.

Mabel Jackson, an adjunct chemistry instructor at Forsyth Technical Community College in Winston-Salem, North Carolina, said the detailed information about biomanufacturers and biomanufacturing processes that she learned at BIOMAN was unlike any other professional development she had experienced. She especially liked hearing from employers about what their needs are.

"If students have questions about where to go and what types of opportunities are available in manufacturing, I will be better able to help with that," she said.

Drug Product Formulation, Fill, and Finish Highlighted at BIOMAN

The industry partners of Ivy Tech Bloomington led the three-day Drug Product Manufacturing workshop. Faculty in the intermediate track workshop interacted with scientists and other personnel from the international biotech companies that have facilities in Indiana. The educators also had multiple opportunities to use industry-scale equipment during a wide range of engaging lessons.

For the first day's session on drug formulation, Jeff Schwegman of AB-Biotech had the educators execute a number of experiments using aspirin tablets and sophisticated lab equipment to illustrate key formulation concepts using an inexpensive, readily available, over-the-counter medicine. He took them through the steps for monitoring the degradation of the active ingredient in aspirin under different conditions. Faculty also learned the mathematical calculations and charting for exponential decay.

For the second day's sessions on the primary manufacturing of parenteral drugs products, Mark

Kruszniski and Cindy Webster of Cook Pharmica gave participants a thick, ring binder of educational materials. From the glossary of parenteral manufacturing terms to the straightforward explanations of the processes used to produce sterile drugs for injection, the educators received detailed information about technicians' responsibilities in the manufacturing of parenteral drugs that are typically administered by injection, skin patches, or ointments. Participants also had the opportunity to learn about and use the equipment utilized by technicians.

On the final day, Cook Pharmica employees Jo Anne Jacobs, Jonathan Balash, and Cindy Webster, summarized the important tasks that technicians carry out in testing, inspecting, packaging, and labeling parenteral drug products. They provided an overview of FDA guidelines and recommendations for labeling and packaging. They also explained the challenges involved with ensuring that drug products maintain their integrity during processing and storage.



After explaining peristaltic processes for filling parenteral drug vials, Matt Eberle (left) of Cook Pharmica assists Linda Rehfluss in the operation of industry-scale equipment. Jim Dekloe observes Rehfluss while waiting to use the equipment.



Sonia Wallman and Mark Kruszynski of Cook Pharmica test the integrity of a syringe filter.

BIOMAN participants gained valuable insight into the biomanufacturing industry and observed technicians at work while touring one of three local biomanufacturing facilities on the afternoon of the third day.

At Cook Pharmica in Bloomington the educators were treated to a closer look at the primary and secondary manufacturing processes that Cook personnel described during BIOMAN workshops on drug product manufacturing.

At Cook Medical in Bloomington BIOMAN participants heard presentations from several staff members. Technicians demonstrated the intricate handwork required to finish catheters and several other medical devices. Designers explained the development and utility of other products.

At Eli Lilly and Company's training facility in Indianapolis BIOMAN participants learned about the safety instruction and in-house education programs for employees.

Advanced Stem Cell Techniques Shared with Educators

At the Myoblasts to Osteocytes Workshop, the advanced track option at BIOMAN 2015, educators learned about several types of stem cells and sub-culturing procedures that they can introduce in their biotech courses to inform students about the basics of regenerative medicine.

Hands-on workshop activities focused on sub-culturing mouse myoblasts from the cell line C2C12 with Bone Morphogenetic Protein 2 (PBMP2). This process directs the differentiation from myoblast or muscle cells to osteoblast or bone cells.

Maggie Bryans also provided detailed information about a three-week protocol with mouse embryonic stem cells that she uses in a course at Montgomery County Community College in Blue Bell, Pennsylvania. Bryans is an assistant professor of biotechnology there and co-principal investigator of NBC2.

By following the protocol, her students have differentiated stem cells into neurons and beating cardio myocytes. In addition to outlining laboratory procedures, Bryans shared tips for buying the necessary materials.

The process for isolating mesothelial cells from chicken adipose tissue was the focus of hands-on experiments led by Bill Woodruff, who recently retired as head of the Biotechnology Department at Alamance Community College in Graham, North Carolina. Woodruff is also a co-principal investigator of NBC2.

Prior to entering the cell culture suite at Ivy Tech, all the workshop participants were instructed in the Class 100 gowning procedures. Complete gowning—from hair covers and facemasks down to boot covers—is required in clean rooms and in other biomanufacturing spaces where contamination must be minimized.



Two gowned BIOMAN participants view cells under microscopes while another gowned participant works in a biological safety cabinet.



Kyle Hetrick, adjunct instructor at Ivy Tech Community College, manipulates cells in a biological safety cabinet during the workshop.

ATE Leader Connects with BIOMAN Participants

Celeste Carter's long-distance presentation about National Science Foundation funding opportunities turned into a real conversation with the co-lead of the agency's Advanced Technological Education program for the faculty members in attendance.

Minutes into her presentation, Carter asked the community college instructors what they were working on. She tailored her comments toward the NSF programs that support the types of initiatives that interest them.

"I thought it was a great session, really rich with information and strategies, and tactics and ideas," said Mindy Wilson, a biotechnology instructor at Lansing Community College.

She said it was helpful to learn about MentorLinks and

Mentor-Connect, two ATE-funded programs that provide mentoring to two-year college STEM faculty members. MentorLinks focuses on STEM program improvement. Mentor-Connect provides guidance on ATE grant proposals.

Wilson plans to follow Carter's advice and nominate herself for consideration to serve as an NSF grant reviewer.

She may also avail herself of the option to email Carter questions. During the session Carter explained that she and other NSF program directors respond to content questions from faculty as they are writing proposals.

"It's pretty comforting to know that she will be there when I do have questions," Wilson said.

Keynoter Encourages Students to Pursue Careers, Not Jobs

Robert C. McCarthy, president of VitaCyte LLC, encouraged the educators at BIOMAN to use case studies to help students “start thinking about connecting the dots” between the creation of disruptive technologies, industry’s adoption of these innovations, and the potential for niche businesses to grow from the periphery of the targeted implementation of new technologies.

From his perspective, the 25 years it typically takes a new technology to evolve from discovery to widespread implementation makes it possible to observe trends and position oneself to take advantage of opportunities.

He sees the growth of personalized medicine as a result of advances in genomic sequencing as one of the “profound changes” on the horizon now. In 2004 he started VitaCyte to characterize enzymes for islet cell transplantation, which big companies considered too small of a market.

He pointed out that technological innovations are accelerating the pace of change in life sciences at the same time that large pharmaceutical companies are being rocked by the loss of income from expiring patents on their high-grossing drugs. Throughout the biotech industry, he noted, companies are shedding in-house research and development.

McCarthy urged the biotech educators to help students understand that “employment is a gift to build a career.”

VitaCyte currently employs nine Ivy Tech grads as technicians. “We appreciate the training that has been done,” he said.

He likes technicians who initiate challenging projects that benefit their employer and maintain their own curiosity. “Never stop learning—expand [your] knowledge into adjacent areas aligned with strengths,” he advised.

Indiana Medical Device Company Boasts Unique History

Rick Mellinger, vice president of global marketing at Cook Medical, opened the second day of BIOMAN by sharing information about the history of the medical device company and offering insights about the forces leading to the convergence of biotechnology and medical devices.

Bill Cook began Cook Medical in 1963 and grew it in Bloomington in partnership with Dr. Charles Dotter. Dotter, a vascular radiologist, is considered the father of minimally invasive diagnostic and therapeutic techniques.

The Cook family-owned company’s 16,000 products include several that blend technologies such as polymer catheters that effuse antibiotics.

“The conditions that physicians are taking care of today

are not going away. In fact they are becoming exacerbated ... those companies that can figure out more novel ways to create solutions are going to be the companies that are going to succeed in the future. And that’s why your work becomes so, so important. These simple devices are no longer going to get it done. We are going to have to be much more creative about how we can converge these technologies,” Mellinger told the educators at BIOMAN.

“Our greatest asset is our employees,” Mellinger said of Cook’s 12,000 employees. Cook’s current manufacturing processes utilize both technicians capable of operating highly automated manufacturing equipment and craftspeople capable of precisely stitching abdominal and aortic stents and grafts.

Keynote Address Explains Biologic Drug Formulation Processes

During his keynote on the final day of BIOMAN, Yunsong Li, principal scientist at Cook Pharmica, explained the steps involved and the equipment used in formulation for biologic drug products.

Biomanufacturing technicians at the company carry out a variety of tasks in formulation, fill, and finish processes.

Li said he seeks technicians who know how to use biochemical, biophysical, analytical, and statistical tools.

“Formulation is not very straightforward,” he said, explaining the need for a wide range of skills.

For instance, initial work on a new product typically involves stability studies of proteins to check for

degradation and characterizing protein aggregation.

Technicians use micro-flow imaging to characterize and quantify particles, and to identify their size and shape.

Establishing thermal stability requires the use of differential scanning fluorometry to measure the exposure of hydrophobic patches in the protein structure.

Beyond properly handling equipment and accurately recording results, Li said technicians must discern the results of multiple processes.

“Many times analytical results [are] coming in [from] different directions, and you have to figure out what you are actually seeing,” he said.

Interactive Workshops Cover Various Biomanufacturing Topics

NBC2 co-principal investigators and faculty from NBC2 partner colleges shared their expertise in interactive sessions and hands-on workshops.

Barbara Bielska, biotechnology professor at Northampton Community College in Bethlehem, Pennsylvania, led a session on Enzyme-Linked ImmunoSorbent Assay (ELISA). It is used to diagnose infections and allergies. By arranging participants to grip lab benches in specific ways, Bielska provided a kinesthetic demonstration of how the antibody-enzyme complex binds to antigens. Participants then used goat anti-rabbit IgG antibody to study antibody-antigen reactions.

Sengyong Lee, biotechnology chair at Ivy Tech Bloomington and NBC2 co-principal investigator, shared the training module on tangential flow filtration (TFF) that he developed for Cook Pharmica technicians.

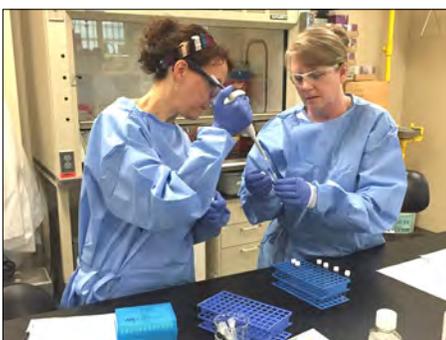
Gretchen Ingvason, senior learning specialist at Mount Wachusett Community College in Devens, Massachusetts, explained biomanufacturers' quality assurance and quality control systems. She also suggested ways to integrate

quality functions into participants' curricula.

Mike Fino, biotechnology chair at Mira Costa College in Oceanside, California, and an NBC2 co-principal investigator, explained the Quality by Design (QbD) framework that biomanufacturers use to connect product quality attributes or outputs with process parameters or inputs.

Sonia Wallman, NBC2's founding principal investigator, led an interactive session on effective strategies for developing local biomanufacturing career pathways.

NBC2 co-principal investigators Maggie Bryans, assistant professor of biotechnology at Montgomery County Community College in Blue Bell, Pennsylvania, and Linda Reh fuss, associate professor of biotechnology and biology at Bucks County Community College in Newtown, Pennsylvania, led the Quality Control Microbiology workshop. The hands-on workshop demonstrated the experiments and testing equipment that biopharmaceutical manufacturers use to prevent microbial contamination of products.



Karen Johnston (left) and Mindy Wilson (right) prepare samples for the LAL assay in the Quality Control Microbiology workshop.



Mabel Jackson (right) collects a sample from a tangential flow filtration system. Barbara Juncosa (left) observes the process.



Participants in the ELISA workshop arrange themselves around lab benches to physically demonstrate the antibody-antigen binding complex. Barbara Bielska (far right) guides the exercise.

California Team Implements BIOMAN Lessons

Three faculty members working in the Orange County Biotech Education Partnership attended BIOMAN as a team. Then after each session they discussed how they would implement the relevant information they learned in the core biotech curriculum they use.

By the final day of BIOMAN, for example, they had a plan for using components from the hands-on workshop on the Expression and Purification of Thermophilic DNA Polymerases in two courses: a protein-specific course and a nucleic-acid-specific course.

"We think the students will really like it because it's very applicable. It's not just this protein that doesn't have a meaning. It's something they can use in PCR," said Kathy

Takahashi, a professor at Santa Ana College in Santa Ana, California.

Her colleagues at the meeting were Anson Lui and Denise Foley. Both are associate professors at Santiago Canyon College in Orange, California.

For the past several years the three have worked together developing the tiered biotechnology certificate program that will be offered beginning in fall 2015 at their colleges. To help students complete the three certificates that apply to an associate degree in biotechnology, course schedules are coordinated across the partnership, which also includes Fullerton College and Irvine Valley College.

BIOMAN Participants Learn Complexities of Standard Instruments

A pipetting workshop provided a multitude of advice for obtaining the best results from the sensitive but frequently taken-for-granted instruments that influence the accuracy of lab work.

Calibration is essential for all pipettes, including new instruments, because pipettes are batch tested at the factory, Candie Gilman advised the educators. She is training product manager for Artel Pipette Quality Management and Technique Certification programs.

Gilman shared Artel's top three recommendations for increased data integrity: pre-wet the pipette tip, immerse the tip to the proper depth, usually between 2 and 6 mm, and pause consistently for one second after aspiration.

Gilman also cautioned that before storing pipettes each day, lab personnel should make sure plungers are in the neutral position so springs inside the pipettes do not become damaged from over-compression.



Candie Gilman (center) interacts with BIOMAN participants as they learn techniques for pipette repair and maintenance.

Gilman's technical advice extended to ergonomics to help minimize injuries among lab technicians.

She suggested that students learn to alternate the use of their right and left hands, check their posture to avoid neck strain and other injuries, and take short breaks away from their tools every 20 to 30 minutes.

Shania Dalton, a vocational rehabilitation major at Forsyth Technical Community College and US Navy veteran, attended BIOMAN 2015 and the Biosciences Industry Fellowship Program to learn about biomanufacturing career paths. Both programs receive ATE support from the NSF.

During her luncheon speech on the third day of BIOMAN, Dalton described what she saw and heard at biomanufacturing companies during the four-week fellowship provided by the National Center for the Biotechnology Workforce at Forsyth Tech in Winston-Salem, North Carolina.

When she becomes a career counselor after graduating in 2016, Dalton plans to direct veterans and their families to bioscience career opportunities. "You have to be versatile and flexible," is a key lesson she plans to share.

Coming Summer 2016!

NBC2 is excited to introduce mini-BIOMAN Conferences! Each mini-BIOMAN conference will highlight a specific area of biomanufacturing. The three-day, hands-on professional development workshops will provide in-depth knowledge of and experience in the most cutting-edge biomanufacturing technologies. At the conclusion of each conference, participants will have a curriculum module that can be readily inserted into an existing biomanufacturing course.

Three mini-BIOMANs are planned for 2016. Topics include Single Use Technology in Bioprocessing; Formulation, Fill, and Finish of a Drug Product; and Stem Cell Production in a Regulated Environment.

Travel funding is available for qualified participants. For more information, contact NBC2 Program Manager Jennifer Imbesi at jimbesi@mc3.edu.

BIOMAN Conference materials from 2015 and all previous years are available on the NBC2 website:
www.biomanufacturing.org

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