

Case Study

BioBuilder Synthetic Biology Kits: Collaboration Brings Advanced STEM Labs to Local High School

Interviewees:

- Dr. Natalie Kuldell, Executive Director, BioBuilder, Cambridge, MA
- Jo-Anne Purdy, Science Teacher/BioBuilder Educator, Westborough High School, MA
- Wendy Courtney, Secondary STEM Specialist, Kingsport City Schools, TN
- Amanda Blackburn, Secondary Science Teacher, Kingsport City Schools, TN
- Evie LaFollette, Secondary Science Teacher, Kingsport City Schools, TN
- Dr. Brian Cinnamon, Chief Academic Officer, Kingsport City Schools, TN
- Maranda Demuth, Corporate Public Affairs Manager, Eastman Foundation, Kingsport, TN

Challenge: Equipping schools to provide students with advanced experiments on innovative STEM topics using professional-grade equipment.

Solution: Collaboration among educators, corporations, foundations, and scientists.

Results: A school that is full of excited young scientists with new visions for their futures.



This is an example graphic I had in mind when I wrote the caption. There are similar ones on the BioBuilder website.
- Chris

Photo caption: Synthetic biology labs engage students' imagination and open their minds to future possibilities.



This is an example graphic I had in mind when I wrote the caption. There is also a good one on the BioBuilder website here:
<https://biobuilder.org/education/for-teachers/>
- Chris

Photo caption: Teacher training is an important first step to the successful implementation of advanced STEM curricula.

Quote:

“It’s a game changer for some of the students to be doing what scientists do. It elevates their knowledge of what scientists do and the possibilities for themselves.”

BioBuilder Synthetic Biology Kits: Collaboration Brings Advanced STEM Labs to Local High School

Have you ever imagined how great it would be for all your students to be able to perform advanced experiments on innovative STEM topics using professional-grade equipment? Or perhaps you are with a company that would like to help local schools enrich their STEM programs with cutting edge resources.

Sound too good to be true? Well, we have a surprise for you—it can be done!

Let us tell you the amazing story of how one Tennessee high school is bursting with excited young scientists thanks to an innovative collaboration of educators, a corporate foundation, MIT-based scientists, and Carolina Biological Supply Company. Perhaps their story will spark ideas on how you can bring advanced STEM opportunities to your local schools.

Synthetic Biology Comes to Kingsport

The science department at Kingsport City Schools in northeast Tennessee experienced significant changes last year. They implemented new Tennessee academic standards, moved into a new STEM center at Dobyns-Bennett High School, and integrated synthetic biology labs into their science curricula. These changes came together at a time when Kingsport educators were looking for ways to elevate their science classes with advanced, college-level topics, real-world investigations, and project-based learning.

Synthetic biology involves redesigning organisms for specific purposes. They undergo genetic modification to acquire new capabilities, such as producing a particular substance, sensing specific materials, or capturing and decomposing various compounds. Synthetic biology is being used today in many innovative ways, for example to clean up environmental contamination, increase the nutritional value of foods, and produce commercial product ingredients¹ (including the new plant-based meat substitutes).

The Eastman Foundation played a significant role in bringing synthetic biology to the Kingsport schools. The Eastman Foundation is the corporate responsibility arm of the Eastman Chemical Company, whose global headquarters is in Kingsport, Tennessee. One of the Foundation's priorities is partnering with local schools to help them build strong STEM programs for their students and with an eye to future Eastman scientists!

The Foundation's leaders recognized the power of synthetic biology to drive future innovation in industry and medicine, so they began searching for a world leader in synthetic biology education. Their search led them to BioBuilder at the Massachusetts Institute of Technology (MIT).

BioBuilder is a nonprofit organization created in 2011 by an award-winning team at MIT focused on synthetic biology. BioBuilder's project-focused curriculum teaches students to integrate biology and engineering by conducting practical, hands-on labs and related activities. The BioBuilder team also provides teachers with professional development that fosters new methods of teaching designed to engage and inspire the young scientists in their classrooms². BioBuilder selected Carolina as a partner because of their commitment to quality, their support of professional development teacher workshops, technical expertise, and extensive life science product offerings. Carolina is the exclusive supplier of BioBuilder lab kits. The professional supplies, equipment, and instruction in each kit are invaluable to students as they conduct advanced, hands-on investigations of synthetic biology. Dr. Mark Meszaros, VP

at Carolina, states, “We are proud to take part in this impactful program as both a supplier and instruction materials provider. We are grateful to partner with BioBuilder as we mutually pursue student achievement with these cutting-edge labs.”

As the Eastman Foundation’s Maranda Demuth explains, “What we love about programs like BioBuilder is it teaches students how to solve real-world problems through advanced sciences that they may never experience otherwise. We find a world leader like BioBuilder that combines all the advanced sciences and a strong reinforcement in writing and research to address real-world issues. BioBuilder was a logical good fit for us.”

The Foundation approached the Kingsport schools about integrating BioBuilder synthetic biology content into their high school STEM curriculum. As Dr. Brian Cinnamon, Chief Academic Officer for Kingsport schools, explains, “We were changing our philosophy in how we approach teaching and learning, shifting to more of a project-based approach. So the opportunity to include BioBuilder content was a perfect way to do that.”

Teacher Training and Lab Prep

The first step to the successful integration of BioBuilder is for the teachers to learn the curriculum and labs. In January of 2019, Dobyns-Bennett's biology teachers, including Kingsport teachers Amanda Blackburn and Evie LaFollette, and science specialist Wendy Courtney, traveled to Boston and spent a week at MIT learning BioBuilder. The Eastman Foundation also sent two STEM faculty from East Tennessee State University (ETSU) to the training. ETSU is in the northeast Tennessee region, close to Kingsport. The Kingsport high school teachers and ETSU faculty learned the BioBuilder content together, forging a relationship of mutual support as they both adopt BioBuilder in their classes.

Dr. Natalie Kuldell, BioBuilder’s Executive Director, and veteran BioBuilder high school teacher Jo-Anne Purdy worked with the educators in the MIT lab. They first had the teachers conduct some of the BioBuilder labs from a student’s perspective—without any prior knowledge of the procedure! Ms. Blackburn tells how “at first, we were confused because we didn’t understand all the bits and pieces. It made us realize ‘I know what my kids are going to do. I just have to figure out what I’m going to do.’” Then the second time we ran it, it was a walk in the park. It was much more user-friendly than we were letting it be the first time.”

When the week of training was complete, the Kingsport educators returned home where they continued to study the BioBuilder content and share it with their colleagues. In July of 2019, Kuldell and Purdy traveled to Kingsport to work again with the Dobyns-Bennett teachers as the time for implementation approached. They answered the teachers’ questions and watched them conduct the labs again using BioBuilder curriculum and Carolina kits, this time with experience under their belts. As Ms. LaFollette says, “we did it again from the teacher perspective and we were like, ‘Wait a second, it’s this easy.’”

“Before BioBuilder, if someone had said to us, ‘Hey, we need you to teach your kids synthetic biology,’ I’m pretty sure we’d have looked at them and laughed!” say Blackburn and LaFollette, “Then we met Natalie and the people at BioBuilder, and they were helpful and knowledgeable and made it so simple.” They also found that the lab kits from Carolina make it easy for the teachers while also helping them meet the new 3D learning-based science standards.

While BioBuilder training was going on, the Kingsport teachers and administration were also working to outfit their new STEM center lab. Some of the advanced techniques used in the BioBuilder experiments require college-level equipment. As Dr. Cinnamon explains, “We planned for what we call 21st century labs as part of our new STEM center, but even in that planning we did not have some of this equipment on our radar.” Dr. Kuldell and Carolina assisted the school in choosing equipment for the new lab, which is now fully outfitted with Carolina’s advanced technology.

This collaboration among diverse organizations provides teachers with a dedicated support system as they implement BioBuilder in their classrooms and labs. Dr. Kuldell and her team are always available to answer questions and provide assistance. Carolina provides kits that make it easy for teachers to teach the labs and excellent technical support when teachers need additional assistance. Scientists and engineers at Eastman Chemical act as mentors for the teachers and the students, as do ETSU faculty. As Dr. Kuldell says, “It is a partnership all around in support of the Dobyms-Bennett teachers and students.”

Student Impact

The Dobyms-Bennett High School science educators have watched their students respond in amazing ways to the BioBuilder labs. The first lab is “Eau That Smell” in which students change stinky-smelling bacteria into bacteria with a sweet banana-like smell. Students learn to grow microbial cells, measure their growth, analyze their genes at a molecular level, and learn basic synthetic biology concepts related to system design and logic gates².

“It’s a game changer for some of the students to be doing what scientists do,” explains Ms. Courtney. “When I’ve been in the classroom with them, the kids have their lab coats and safety goggles on, and they’re doing what scientists do and saying, ‘this is what scientists really do; I could do this; this would be a great profession to do or something like this job.’ It elevates their knowledge of what scientists do and the possibilities for themselves.”

In addition to getting students excited about science, BioBuilder also challenges them to a higher level of learning and thinking. Ms. Blackburn describes it well: “When we do the lab, we ask the kids, ‘If you were creating, what would you do? What problem would you solve? Where would you want to go with it?’ The student becomes the scientist in that role. They become student scientists. It gets them to start thinking in scientific and engineering ways, and it has been really exciting to see. I think their whole approach and understanding are stronger because they have this experience that ties things together.”

The Kingsport administrators and teachers are committed to making BioBuilder available to students of all levels of ability. “We teach a lower level of biology with students that often have Individualized Education Programs (IEP),” explains Ms. LaFollette, “and then we have a general biology class and an honors biology class. So, we’ve seen the full spectrum of students doing the BioBuilder labs and they all enjoy it. They’re asking, ‘When do we get to do the next one?’” Now that’s exciting to see!

Over the next four years, all 2,500 students at Dobyms-Bennett High School will have hands-on training in synthetic biology. The hope is that the students will use their BioBuilder experience to further their educational and career goals and later at ETSU or Eastman Chemical Company!

Replication Encouraged

We hope that as news of this innovative collaboration reaches more members of the educational community, it will inspire other schools and organizations to consider new opportunities for themselves. Kris Krautkremer, AP Biology Teacher at Dobyns-Bennett High School, recently helped to spread the word while at the White House Federal STEM Education Summit. She sent this message to Dr. Kuldell:

“We were discussing how our local communities are implementing the STEM Education Strategic Plan. My table was overwhelmed when I spoke of how our new STEM building with all of its resources facilitated learning for all students in STEM. I shared about our partnership with Eastman, in particular BioBuilder, and how our students bioengineered microbes by adding genes to express compounds smelling like bananas, and the extensive professional learning Eastman provided for all biology teachers with Natalie at MIT. No other PAEMST Awardee from any other state had anything similar to share. I’ve always, always appreciated how our local partnerships empower what I do, but their faces spoke volumes. Every one of them would have loved to have the support we have in Kingsport. Thank you for all you do to support what I do.”

- 1 Remember, a journey always begins with that first step! Visit the Carolina (<https://www.carolina.com/xm/biobuilder>) or the visit the Biobuilder site (<https://biobuilder.org/>) for more information on that first step.

References:

- 2 <https://www.genome.gov/about-genomics/policy-issues/Synthetic-Biology>
- 3 <https://biobuilder.org/>

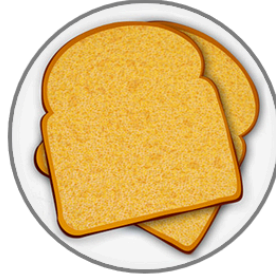
Sidebar idea:

Perhaps use one or more of the brief lab descriptions like these that are available at <https://biobuilder.org/education/for-students/> to give readers an idea of the types of synthetic biology labs in BioBuilder. For the entire suite of kits, visit www.carolina.com/xm/BioBuilder.



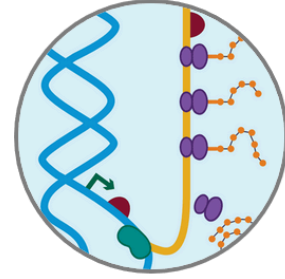
EAU THAT SMELL

In this lab, normally stinky smelling bacteria are made to smell sweet, like bananas. You can learn to grow microbial cells, measure their growth, analyze their genes on a molecular level, and learn basic synthetic biology concepts related to system design and logic gates.



GOLDEN BREAD

With this lab you can explore the science, engineering, and bioethics of a yeast that's genetically modified to make a vitamin-enriched food. Explore how the cell's "break," how to fix them, and what they might do in locations where Vitamin A-deficiency affects public health.



ITUNE DEVICE

This lab focuses on predictable design. You can learn to assess the strength of genetic "parts," such as promoters and ribosome binding sites, to see how they influence the output of a genetic device.