MUTANT SUMMER

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High school students and their teachers witness evolution in action. The program uses bacterial colonies.

EVOLUTION UP CLOSE, ALL WET AND SQUISHY | BY JENNY BLAIR

Picture two lab dishes inches apart, each containing a layer of gel studded with cream-colored bumps. On one dish, the bumps are shiny circular domes. On the other, they look very different—wrinkly and ruffly like lace.

The bumps are colonies of bacteria from the same species. The simple colonies are ancestors; the elaborate ones have evolved to function differently. That change took place in one week.

"Seeing evolution happen in real time is just so captivating," says Vaughn Cooper, a professor of microbiology and molecular genetics at Pitt Med. In an interview with Pittsburgh's NPR news station, WESA, he recalled that "the first time I saw, as a graduate student, bacteria evolving in real time, I knew that this had to be the way that we learn about evolution."

That realization led to him found the nonprofit EvolvingSTEM, which provides high school students with that same "captivating" learning experience.

The microbiology experiment is the centerpiece of EvolvingSTEM's curriculum. "Learning by doing works. We know this," says Cooper. "But the life sciences have lagged well behind in learning-by-doing relative to, say, computer science, math, engineering, physics. You can kit that and distribute that remotely, but life sciences requires squishy things. Wet things."

Wet and squishy is about right. In the experiment, students squirt a solution of harmless, genetically identical bacteria into a test tube that contains a plastic bead. After letting the bacteria multiply for about 24 hours, they fish the bead out and transfer it to a fresh tube that contains a clean bead. Then they wait again.

In the initial generation, most or all of the bacteria float indifferently around the bead. But as they divide and multiply, some develop random genetic mutations that allow them to form a sticky slime, or biofilm, and adhere to the beads.

With each bead transfer, cells whose genes favor that knack for stickiness are selected. Riding the bead out of one tube and into the next one, they pass the trait to the next generation. The bacteria go through about six generations a day.

Early in the experiment and again after a few transfers, students spread a solution of bacteria over a gel-filled Petri dish. There, each individual bacterium gradually gives rise to a single colony.

Bacterial colonies from mutants that are good at forming biofilms look wrinkled, unlike their ancestors' smooth, round colonies. It's clear evidence of evolution. And it's relevant to medical science: Bacteria that cause chronic infection are often excellent biofilm formers, and the mutations that get them there are the same ones causing these changes in the classroom.

Currently, students attending 15 high schools in eight states participate in EvolvingSTEM; many of them come from communities traditionally underrepresented in STEM careers. "If we can offer the experience in the freshman and sophomore years, that's when you get the broadest, least discriminated population," says Cooper. "You have the greatest chance of hooking a diverse pool of people who wind up considering careers in STEM."

For years, Cooper used discretionary funds to purchase supplies and pay instructors to bring the module to classrooms. But the School of Medicine has stepped in with a three-year, $90,000 annual commitment to sponsor EvolvingSTEM during the academic year. And in early 2022, a nearly $600,000 three-year grant from the National Science Foundation began funding a new eight-week summer program on Pitt's Oakland campus. There, middle and high school teachers gather for training, stock up on supplies and fan out to their classrooms to take students through the experiment.

In a 2019 paper published in Evolution: Education and Outreach, Cooper and his coauthors documented that EvolvingSTEM students learn about 50% better on a common assessment of knowledge about evolution and heredity.

"Doing science is the best way to make scientists," says Cooper, whose lab focuses on the evolution of infectious disease and evolutionary processes in microbial populations. When he reflects further on EvolvingSTEM, he adds: "It's the most important work that we do." ■