Going Viral

SEA’S HANDS-ON LAB APPROACH TAKES ON LIFE OF ITS OWN.

When biology professor Ann Findley first considered teaching a research course to freshmen at the University of Louisiana at Monroe, she wasn’t certain they could meet the challenge. Coming from rural school systems, many of the students had never set foot in a science lab.

“Not only have they stepped up, they’ve soared and become peer leaders on campus,” says Findley. The assumption was that a research-based program would succeed only at elite universities or among honors students. “We’ve been able to prove that even truly novice students can do research at a very high level and benefit from it in exciting ways we never could have imagined.”

Participants from the 10 other colleges and universities that pioneered HHMI’s phage course, formally known as the National Genomics Research Initiative, share Findley’s enthusiasm. So much so that even though their three years of HHMI support are ending, each of these schools has committed to continuing to offer the course. The introductory bio lab course thrusts freshmen into the world of research instead of parking them in the more traditional bio lab of “experiments” with preordained outcomes.

This first cohort of schools (the fourth cohort starts this fall) is working to offer the course to more freshmen, expand research opportunities to upperclassmen at their own institutions, and spread the program to other colleges.

“We really want to go viral with this idea of early research experiences; it’s just so exciting and valuable,” says professor Louise Temple of the Integrated Science & Technology Department at James Madison University in Harrisonburg, Virginia. Temple is leading the effort with 17 other institutions—7 of them from the first cohort; 6 from the second—to secure a National Science Foundation grant to create a network that supports the expansion and diversification of the phage course model to include other organisms and other universities and colleges.
The phage course is a relatively simple concept based on work by HHMI professor Graham Hatfull at the University of Pittsburgh. Students isolate novel viruses that infect bacteria, called bacteriophages or phages, from soil, and then purify them, isolate their genomic DNA, and send it away for DNA sequencing. When the sequence comes back, the students employ bioinformatics tools to annotate and characterize their new-found phages.

From start to finish, there are no guarantees of success or right answers. Students endure the pitfalls of true research, such as contaminated bacterial plates and inscrutable results, along with the thrill of discovery and eureka moments small and large. “Just because something is effective, doesn’t mean that it’s always a comfortable experience to go through,” says Grant Hartzog, a professor at the University of California, Santa Cruz. “These [students] are getting pushed to think hard in ways that they aren’t used to.”

And the phage course is effective. As the first initiative of HHMI’s Science Education Alliance (SEA), which now encompasses 67 schools, participants have been documenting their experiences: students participating are more likely to continue in science courses and perform significantly better in lecture courses than peers in traditional laboratories, says Tuajuanda Jordan, former director of SEA who was instrumental in getting the program off the ground. Jordan notes, “We are born naturally curious and the SEA course engages that curiosity and really helps students develop higher thinking skills.”

The ability to adapt the course to best fit the students and curricula of an individual school is part of what makes it so effective at institutions ranging from elite universities to regional colleges, according to Jordan.

While the course has been built around phages that infect *Mycobacterium smegmatis*, a cousin of the bacterium that causes tuberculosis, some schools are switching to different organisms because they are less expensive or easier to work with or represent “uncharted” territory. For example, the University of Mary Washington, in Fredericksburg, Virginia, through a collaboration with the Naval Surface Warfare Center at Dahlgren, will look for phages that infect spore-forming bacillus bacteria—common and easily maintained organisms that could inform the Navy’s work on anthrax bacteria.

At the College of William & Mary in Williamsburg, Virginia, the biology department will institute a *Helicobacter pylori* genomics lab course and the environmental science and neuroscience departments will explore the effect of mercury on embryonic development in frogs.

One of the most exciting ways the phage course is evolving takes the effort to upper classmen. The first cohort of schools faced a “problem” when students were eager to continue pursuing questions arising from the phage course work and the schools had nothing to offer them. “Once you’ve sequenced and annotated a phage genome, this is just the beginning of discovery,” says associate professor Aaron Best of Hope College in Holland, Michigan. The annotation process sheds light on new avenues of exploration that truly engaged students want to pursue. “We had a student at the end of the course throw up her hands and ask if this was it?” laughs William & Mary biology professor Margaret Saha. Like most of the first cohort of schools, Hope and William & Mary are developing courses for upperclassmen designed to explore gene expression patterns in the phages they’ve annotated.

“People always ask how we afford to offer this experience,” Saha says. “It’s really not that expensive when you consider what it gives the students and the institution. It’s mostly time and it just works so well.” —LISA CHI

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