

PERSPECTIVES & OPINIONS

Ann Stock

THE THRILL OF MOLECULES

LET HIGH SCHOOLERS
SEE AND TOUCH SCIENCE.

Paul Fellers

Ann Stock knew that high school students would enjoy getting their hands on molecular models. But the HHMI investigator and structural biologist at the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School had no idea how much she'd get out of it as well.

Through inquiry-based education, students learn the process of science rather than just the facts about science. Structural biology is a wonderful way to do that; it's something that students latch onto very quickly. With a structure in hand you can start to understand a protein's function.

That's the underlying basis of the SMART Team Program. SMART stands for "students modeling a research topic." Teams of high school students and their teacher work with a local research lab to design and build a physical model of a protein being studied by the lab. I had my first chance to mentor a team of students in 2008–09.

My team from Pingry School in Martinsville, New Jersey, modeled a family of response regulators involved in bacterial signaling pathways. We used the models to explore different protein domain interactions and conformational changes induced by phosphorylation. Mentors try to choose projects relevant to current issues in science and health. In our case, bacterial signaling relates to antibiotic development. The students begin to see the molecular details in the broader context. They've all heard about MRSA and *Staphylococcus aureus*.

The students—just sophomores—got an incredible introduction to science and molecular biology. By the end of the project, the kids had a visceral understanding of their molecule, what it is, how it functions, and its dynamics. They also gained enormous confidence that they can do science, explore, and ask questions. When the students presented their work at the national American Society for Biochemistry and Molecular Biology (ASBMB) meeting, they walked away with a prize.

I was amazed by how much a sophomore in high school can understand and appreciate. They gain real intuition and insight into a protein structure after an experience like this.

During the program, the students used small magnets to simulate electrostatic interactions. The weak magnets required very specific positioning, but the team became remarkably good at aligning the molecular components. We split the eight students into teams of two to develop models to explain particular features of the proteins. It was fantastic to watch them work: Their different skills showed through just like one sees in laboratory research teams. Some were facile

with computers, others had deeper understanding of biology, some picked up structure quickly.

For me, there were expected and unexpected benefits. For one, we received a set of these expensive models, which are wonderful tools for our lab. And it took surprisingly little work. The SMART team setup allows for interaction between high school students, their teacher, and their university mentor, but with a minimal time commitment from the mentor. The students visited three times during the year, and I went to their school once. I wanted to see them in their environment and listen to their rehearsal for the ASBMB meeting.

In addition, the program gave my lab members great training to create a culture where education matters. Today's graduate students and postdocs pursuing a career in academics have an interest in teaching, especially inquiry-based teaching. Many didn't have exposure to experimental science early in their careers, and they realize its import.

SMART teams rotate to different mentors each year, but I had such a good time I've found a way to stay involved. At the ASBMB meeting, Pingry teacher Deirdre O'Mara and I attended a workshop by biochemist J. Ellis Bell from University of Richmond. Bell's freshman biology students spend the entire semester exploring a protein, making mutations, then analyzing the effects. Impressed, Deirdre and I decided we could build a class around the models we worked on last year. She spent a month in our lab over the summer learning the techniques needed to have the students construct mutants and run assays. This spring, we will ask her students to read two conflicting papers, evaluate the conclusions, and then, based on what we've seen in crystal structures, create a hypothesis that updates the story or overturns previous conclusions. I anticipate that they'll end up with a publication out of this work that will contribute to the field.

It's an interesting experiment to see how far one can take high school lab science. Unfortunately, it requires resources and motivated teachers. Pingry is a private school with beautiful lab facilities. It would be wonderful to be able to extend this program to public school systems. HHMI is funding centers to train high school teachers to become leaders of SMART teams. The limiting factor is teacher training; finding mentors won't be difficult.

INTERVIEW BY CORI VANCHIERI. Ann Stock is associate director of the Center for Advanced Biotechnology and Medicine, a research institute at Rutgers University and UMDNJ–Robert Wood Johnson Medical School. See page 38 for a science education story on the SMART teams.