



## No Dozing Off

**Clad in matching** team T-shirts and carrying backpacks, a dozen or so California high school students formed a circle, leaned in to touch hands, and chanted “1, 2, 3, CELLBOTS!!” Flinging their arms skyward, they dissolved into laughter and then filed into a lecture hall at the Massachusetts Institute of Technology in Cambridge, ready to go for the gold.

Gold meant earning one of the top scores in the 2009 International Genetically Engineered Machine competition (iGEM), designed to fuel enthusiasm in synthetic biology—a merger of biology and engineering.

The teenagers from Abraham Lincoln High School, an urban public school in San Francisco, were jet-lagged but feeling good about their chances against 112 elite college teams from around the world.

There was, after all, a stirring precedent. In 2007, HHMI investigator Wendell A. Lim, a molecular biologist at the University of California, San Francisco, had coached Lincoln High’s first iGEM competitors to a stellar 6th place finish among 54 squads from prestigious colleges and universities.

This was a triumph, especially in light of Lim’s initial reservations. “My first reaction was to think it would be a disaster to plop high school students in the middle of a serious research lab,” he admits. He needn’t have worried.

Each iGEM team conceived and built a project using a toolbox of “standard, interchangeable biological parts”—including bits of DNA, promoters, ribosome binding sites, protein-coding sequences, plasmids, and other raw materials.

The Lincoln team, with teacher and former Genentech scientist George Cachianes, tried to harness the navigational ability of white blood cells called neutrophils and steer them to carry molecular payloads. They could imagine programming their “cellbots” to deliver drugs to specific targets.

Over the summer, the charged-up students willingly worked long hours, learning by doing—and by trial and error. “I am behindddd!” wailed one team member in his blog. “We grew cultures overnight yesterday hoping to do minipreps and digests today, but we forgot to add antibiotics to our media. Oh, boy.”

The students learned to adapt to Lim’s serious and demanding style and to take it all with good humor. “We sometimes joked before lab meetings that it was gonna be a long one if Wendell was there,” recalls Jacqueline Tam.

And they learned the worth of Lim’s mantra—“keep it simple,” she says. “Whenever I’d go off on a long spiel when we were practicing our

presentations, he’d say, ‘Sorry—I dozed off. What were you trying to convey on this slide?’ This really helped simplify our ideas.”

At the November competition, the Cellbots team earned a silver medal but didn’t place among the finalists. Tam acknowledged the team’s disappointment at the outcome but says, “we are definitely very proud of our team, our project, and what we accomplished.”

Lim is far from disappointed. He’s already signed up to coach next year’s team.

“These young, smart people don’t have the biases of experience about what’s possible and not. They are an incredible source of creative, out-of-the-box ideas.” —Richard Saltus and Jenny Cutraro