

JULY 2009

Notebook

The first two weeks of samples from Lawrence David (L) and Eric Alm (E).



The number two-ome

Eric Alm bursts into the Massachusetts Institute of Technology lab and grabs a small, maroon-colored sports duffel bag. “Give me seven and a half minutes,” he says with a sense of urgency. “I’m taking a sample and I know exactly how long that takes me.” Into the duffel bag he stuffs a disposable plastic commode about the size of a fedora hat, latex gloves, an autoclaved sampling tube, and a biohazard container.

“I’ve been extremely stressed out today,” Alm says.

“Have you been taking your blood pressure?” Lawrence David asks eagerly.

“Yeah, it was really high. This should be interesting.”

Alm, an evolutionary microbiologist, and David, his graduate student, are engaged in what they’re calling the HuGE (Human Gut Ecology) Project—

an effort to track how the microbial communities in their own digestive tracts change over time. “The point is to figure out the normal dynamics of what’s probably the densest microbial community in the world,” explains David.

Bacterial densities in the colon can reach up to 1 trillion cells per milliliter of feces. But researchers don’t know how this vast microbial ecosystem changes from day to day. In the past, initiatives such as the Human Microbiome Project—a 5-year, \$115 million program spearheaded by the National Institutes of Health—have focused on characterizing the gut flora in groups of people, but not on a fine temporal scale.

But to the MIT researchers, the relevant measure of time for the gut is 24 hours. This is the timescale at which bacteria replicate, thus daily sampling is necessary to reveal the system’s true dynamics, Alm says. Naturally, “that’s a lot of sampling.” With his shoestring budget of start-up funds from MIT and the Broad Institute, Alm realized no stranger would volunteer to take part in

his proposed study—so he signed himself up. He then polled his graduate students for their levels of interest. “Most of them gave me a strange look, except for Lawrence [David],” Alm recalls. “I said, ‘Are you interested in this?’ And he said, ‘You have *no* idea how interested I am.’”

Since April, Alm and David have been going to the bathroom and taking core samples of their feces, as well as tracking around 100 different metrics of their personal health and daily habits—diet, exercise, mood, sleep patterns, oral hygiene,

“We’ll be the first two complete years’ worth of feces sequenced.”

heart rate, blood pressure, you name it—to see if samples change with daily routines. After the collection phase, scheduled to continue for 6 to 12 months, they ultimately

plan to analyze their stool samples using small-subunit (16S) ribosomal RNA gene-sequence-based surveys to characterize their bacterial communities on a day-to-day basis. Alm’s postdoc Arne Materna will then have the unenviable task of sequencing the species within the fecal matter.

“This is the part I’m still trying not to think about,” says Materna. He is using the HuGE project as a test case for a new multiplexed sequencing approach that should allow researchers to probe the microbial diversity of many different samples simultaneously, and with a high degree of accuracy, for a mere \$10 a sample. “It will become a game changer,” Materna says.

The two researchers are fervently embracing the project. Their wives, however, are less enthusiastic. “My wife has expressly forbidden me from keeping samples in the house,” says Alm, who drives to work on the weekends to get his samples promptly into the -80°C freezer. David’s wife, however, is more accommodating. “I was eventually able to convince ▶

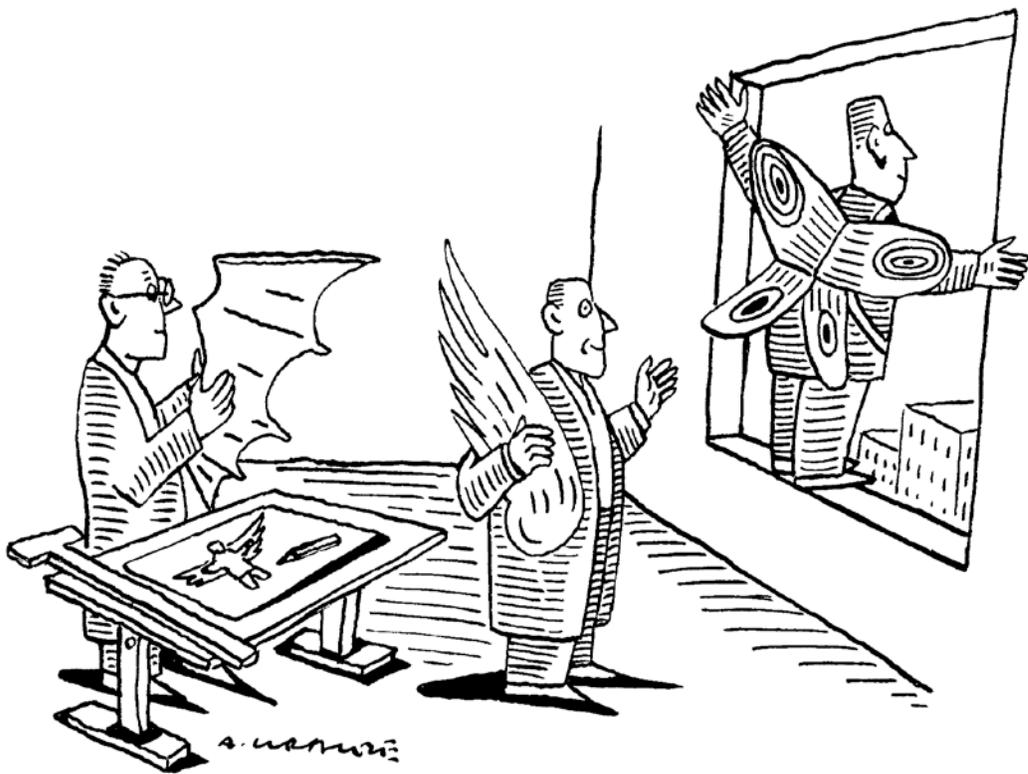
my wife that [storing feces at home] is a reasonable thing to do,” he says. “[The samples] live next to the chocolate ice cream. She’s not very happy.”

But it’s all in the name of science, they contend. In January, David wrote a post on his personal blog describing the two of them as the “Watson and Crick of poop.” But Alm was quick to correct him. They’re the Watson and Venter of poop, he argued, referring to the first two men to have their own entire diploid genomes sequenced. “We’ll be the first two complete years’ worth of feces sequenced,” says Alm. “But right now, it’s just a freezer full of shit.” —**Elie Dolgin**

Picture 50 architects, designers, and scientists from companies like IDEO, General Electric, and Boeing behaving like a flock of birds. If they were trying to fit in with their neighbors at the zoo, the flamingos and gorillas didn’t take notice, but stroller-pushing tourists did. Tousle-

Think beach sneakers modeled on camel feet, and tents like armadillo shells.

haired children poked their heads inside the massive open-air pavilion where the conference took place to see what was going on. A lot, it turned out.



Like life

To get to know the Biomimicry Guild is to learn its biology-inspired lingo: Its members aren’t a group—they’re a “meme.” They don’t reject ideas—they have an “immune response.” And when they inaugurate a conference, like they did this winter at the San Diego Wild Animal Park, they don’t clap. They caw, hoot, tweet and gobble.

It’s been 12 years since founder Janine Benyus published her treatise, *Biomimicry*, to wide acclaim, and 6 years since her first workshop on how to incorporate lessons from biology, what she calls “Life’s Principles,” into design and manufacturing. In that time, 240 people have passed through the guild’s weeklong workshops and 2-year fellowship program. But until this particular weekend, the guild had never held a

reunion for alumni to share lessons from the field. So on a sunny San Diego day—ringed by lions, rhinos, and condors—the graduates came home to roost.

“In addition to training practitioners, an important part of our job is to deepen the thinking. We’re part of a Socratic dialogue that’s going on within the biomimicry community,” Benyus told me while we watched a pair of adolescent gorillas wrestle in their pen.

Between hugs and debates on sustainability over plates of potatoes au gratin, graduates presented their work. David Hammond, for example, a chemical ecologist from Berkeley, California, discussed Nike beach sneakers he designed inspired by camel feet, whose rubber soles spread to prevent sinking into the sand (the surface area gets successively larger as the soles sink).

Dennis Lin, a senior engineer at Boeing’s Concept Center, spoke disappointedly about using the penguin as inspiration for commercial airplane design. He hoped to understand the way penguins adapt to rapid temperature extremes to learn how to prevent condensation inside the cabin. The comparison didn’t work. The temperature shifts around a plane after liftoff are too drastic relative to what penguins experience, he said. “I guess we painted ourselves into a corner.”

Bruce Hinds and Carl Hastrich, professors at Ontario College of Art & Design (OCAD), showcased slides of their students’ work, including camping tents modeled on armadillo shells and skirts shaped like dahlia petals. And sprinkled between were heavy hitters like designer David Oakey, whose modular carpet design is based on the forest floor, and Benyus herself, who talked about what sustainable industry can learn from biology.

Industrial methods of production use intense amounts of heat and energy that generate toxins harmful to organisms and the environment, whereas “life creates conditions that are conducive to life,” Benyus repeated throughout the weekend. Mimics are searching for ways to create products at room temperature without toxic chemicals, similar to ways mussels grow shells or spiders spin silk.