World Class
Global health curriculum initiatives encourage undergraduates to embrace—and solve—real-world problems.

BY MEGAN SCUDELLARI

ILLUSTRATIONS BY JOSH COCHRAN
REBECCA RICHARDS-KORTUM couldn’t get the four tiny newborns, crowded shoulder to shoulder in a single plastic crib, off her mind.

It was 2005, and Richards-Kortum, a bioengineer and HHMI professor at Rice University, was returning home from Malawi, a landlocked African nation and one of the world’s least-developed countries. While there, she’d visited the neonatal intensive care unit at Queen Elizabeth Central Hospital. It was an institution that lacked sufficient space, adequate resources, and equipment to perform even the most basic medical tests and treatments.

When she got back home to Houston, Richards-Kortum challenged her students to help babies like those four newborns. Jocelyn Brown, a senior bioengineering major, and four other undergraduates accepted the challenge and spent the next year researching and designing a device that the pediatricians at Queen Elizabeth had requested: a bubble Continuous Positive Airway Pressure (bCPAP) system, which blows an oxygen-rich air mixture into the lungs of premature babies to help prevent the respiratory problems that often afflict preemies.

Hospitals in the United States use a $6,000 bCPAP machine, but that price tag wasn’t feasible for a Malawian hospital. Brown and her teammates constructed a prototype for less than $200 that offered the same therapeutic flow and pressure as the systems used in Houston hospitals. “I knew students had the skills to design technologies that could truly improve health care,” says Richards-Kortum. “That was the start of it.”

Today, Rice is home to one of several HHMI-funded programs that incorporate global health in undergraduate curriculums. The need for such programs is great, says HHMI Professor Muhammad Zaman, a bioengineer at Boston University (BU). Many engineers and scientists have knowledge that is deep but not broad, so they may be unaware of how their work can apply to and affect the real world, especially in resource-poor settings. “Global health education is an opportunity to understand how policy, social and cultural barriers, religion, and the structure of society affect health,” says Zaman. “All of these things are connected, and that’s important for our engineers and scientists to know.”

Such programs not only support the development of solutions to critical global health problems, but also engage students in real-world problem solving, says David Asai, senior director of undergraduate and graduate programs for HHMI. “Given the internationalization of everything we do these days, leading schools will be thinking more and more about what’s going on in the whole world.”

Breath of Life

Brown continued to work on the bCPAP project after graduating in 2010. She traveled with the machine to Malawi and demonstrated it to physicians and nurses, who offered feedback. With that input, she improved the design and then returned to Malawi to conduct a nine-month clinical trial in 89 infants to test the effectiveness of the machine.

The student-designed bCPAP device improved the average survival of premature infants with respiratory distress syndrome from 24 percent to 65 percent, says Brown. “It was absolutely exciting and validating to know that we had developed this device, it could be used, and it worked well.”

The bCPAP device was the first of many technologies to come out of Rice’s Beyond Traditional Borders (BTB) initiative, an undergraduate biomedical engineering design program founded by Richards-Kortum and her colleague Maria Oden under a 2006 HHMI science education program grant.

In 2013, BTB won the $100,000 Lemelson-MIT Award for Global Innovation. Richards-Kortum and Oden donated the prize money toward the construction of a new neonatal ward at Queen Elizabeth Central Hospital.

Today, the BTB program – which incorporates coursework, design challenges, internships, and outreach programs – has trained more than 10 percent of all Rice’s undergraduates since the program’s inception. And BTB
undergraduates have built and tested an estimated 116 prototypes for use in the developing world. Last year, for example, a group of freshmen designed a handheld device that accurately and quickly measures respiratory rates in children – a critical parameter for diagnosing pneumonia. “Using just a microprocessor and a couple of LEDs, they did a lot of great engineering,” says Richards-Kortum. Those students were in Malawi this past summer, demonstrating the device to nurses. With their input, the students will spend the coming academic year improving the device and planning a clinical trial.

Other technologies under development in the program include a liquid-medicine dosing syringe for children with HIV/AIDS, a solar-powered autoclave, a hand-powered centrifuge, and a battery-powered fluorescence microscope.

As for the bCPAP device, Rice licensed the machine to 3rd Stone Design, a California company where Brown now works. With funding from the United States Agency for International Development (USAID), the company distributed devices to all 27 hospitals in Malawi and now is preparing to mass-produce it to sell in other developing countries.

“For myself and my classmates who have gone through the program, it is really exceptional to make things that will actually be used in the world,” says Brown. “It is compelling to know, as a young engineer, that I can make a huge impact on health.”

**Leading by Example**

On a quiet street tucked behind Boston University’s bustling urban campus, Muhammad Zaman says goodbye to four undergraduates and a postdoctoral student also eager to make an impact on health. The five are headed to the airport to catch a plane to Zanzibar, an archipelago off the coast of East Africa, where they will spend six weeks living with host families and working with local students to brainstorm health-care technologies needed in the region.

After seeing them off, Zaman, who became an HHMI professor in 2014, walks back through a door leading to his two laboratories. In the lab to the right, he studies how cancer cells interact with their environment. In the lab to the left, he focuses on global health.

Zaman grew up in a developing country, Pakistan, and experienced firsthand the poverty and lack of medical technology that are endemic to such settings. As a boy, Zaman tagged along with his mother whenever she trekked across town to pick up medications. She never went to the pharmacy on the corner by their house, Zaman recalls. For the longest time, he thought that was just the way it was done – you traveled across town for medicines. “Then I came to America and realized that’s not how it should be,” he says. Zaman realized his mother’s long trips were necessitated by her distrust of the quality of the medicines at the corner store.

In 2011, with funding from USAID’s Promoting Quality of Medicine Program, Zaman began developing an inexpensive, portable kit able to detect counterfeit and substandard drugs. An estimated 10 to 30 percent of the drugs sold in parts of Africa, Asia, and Latin America are counterfeit, and a whopping 30 to 50 percent of all antimalarials are estimated to be substandard. The prototype kit, which Zaman calls PharmaChk, is a black plastic container about the size of a carry-on suitcase. It’s a laboratory-in-a-box, complete with tiny test tubes, fluorescent probes, a microfluidics chip, and more.

In 2013, *Scientific American* hailed PharmaChk as one of 10 “World Changing Ideas.” With the device, Zaman hopes to ensure that medicines are safe at all points along the supply chain – from manufacturers to distributors to corner stores in Pakistan.

As he was building PharmaChk, Zaman discovered that his students were as passionate about global health as he was. “This is the Facebook generation; people are getting more connected and are socially conscious,” he says. The interest from his undergraduates, combined with his own origins in a developing country, led Zaman to embrace and become a model for incorporating global health into science courses. In one of his current undergraduate courses at BU, for example, Zaman uses burn injuries and postpartum hemorrhage to teach the concepts of heat, mass, and momentum transfer in living systems.
Today, Zaman is working to help other professors at BU do the same thing. With students, he has built a university-wide online repository where anyone—student or professor alike—can propose a global health topic. Once an idea is suggested, his team converts the concept to useful, bite-size nuggets, such as exam questions or project ideas. Faculty can then pull from that list for lessons and assignments, and Zaman and others will help them tailor the example to their lesson—be it chemistry, history, literature, or some other topic.

The goal is to incorporate global health examples into as many types of classes as possible, says Zaman. For now, the resource is internal to BU, but he hopes to eventually make the system accessible to other universities.

In addition to infusing undergraduate classes with global health material, Zaman is ramping up the globalization of BU’s engineering department. A biomedical engineering program called Quality, Exposure, Policy, Innovation and Implementation in Context, or Q-EPIC, includes a brand new, spring 2016 course called Engineering for Global Development. Q-EPIC will also incorporate global health problems into a yearlong sophomore lab taken by every engineering major at BU, and the summer program in Zanzibar will be available to seven or eight students annually.

“As students graduate and go into the real world, whether or not they stay in engineering, they will always retain this idea of how engineering transforms the real world,” says Zaman. “If there is one thing I want them to come away with, that is it.”

Reaching Out to the World
Not only are large research universities like Rice and BU developing global health programs, but so, too, are smaller liberal arts colleges. For example, three colleges in Pennsylvania recently launched NHMI-funded global health programs.

When Allegheny College in Meadville, in northwestern Pennsylvania, announced a new major in global health for the 2013-14 school year, the response was “rather alarming,” says Lee Coates, a professor of biology. With a 2012 NHMI education grant, Coates and colleagues had spent a year developing the curriculum; as soon as it was announced, nine graduating seniors instantly came out of the woodwork and registered for the major. Freshmen, sophomores, and juniors enrolled in the program as well. “We had faculty interest, and now there was this incredible student interest,” says Coates, project director of the Global Health Studies program.

Kevin Crooks, a sophomore biology major, immediately signed up for a minor in global health. “It was a new area of study, and I knew I wanted to jump right in,” he recalls. Soon Crooks was adding classes in community health assessment and global health transitions to his packed schedule of molecular and cell biology classes.

This year, 18 seniors are enrolled in Allegheny’s Global Health Studies program, and Coates expects it to soon enroll 25 to 30 majors per year. That rapid growth is a testament to the interest in the field and also to Allegheny’s unique approach to global health, through four “pillars”: science, health, and the environment; ethics and social responsibility; policy, resources, and economics; and cultures and society.

“This is a liberal arts approach to global health—it’s bigger than just medical treatment,” says Caryl Waggett, chair of Allegheny’s Global Health Studies program. “Using these broader ways of thinking, students’ skill sets are much better refined when they graduate.”

In addition to coursework, many students in the program participate in either U.S.-based or international internships. About 40 students took part this year in initiatives ranging from a project to encourage breastfeeding in Pennsylvania workplaces, conducted in collaboration with the Women, Infants, and Children federal nutrition program, to internships in Mysore, India, where six students are currently working at health-care–related nonprofits.

Crooks spent six weeks after his junior year at an orphanage in Kenya, performing a systematic analysis of best practices at that orphanage and two others nearby. He found that the ratio of caregivers to children had a huge impact on the children’s lives. “In the larger orphanage, there were 90 children to one or two caregivers,” says Crooks. “It set the children back.”

Since graduating, many of the first nine global health majors have taken positions with service agencies or entered
medical or public health school. Crooks had originally planned to go to medical school, but his experience in the Global Health Studies program changed his mind. Today, he is working on a master’s in public health at Tulane University’s School of Public Health and Tropical Medicine, while also spending two years in the Peace Corps. “I know now I can make an impact, not just be an observer,” he says.

Southeast of Allegheny, another Pennsylvania college boasts a global health initiative. At Ursinus College, located on a 170-acre campus in suburban Philadelphia, biology professor Rebecca Kohn and colleagues saw a need greater than just pumping out biology majors and premeds.

“We want to make sure students are thinking about their impact beyond their career as a doctor or in a research lab,” says Kohn. “We want them to think about how they impact society, how they impact the world.”

With an HHMI education grant awarded in 2012, Kohn and other Ursinus professors initiated the Center for Science and the Common Good, aimed at encouraging science majors to reflect on the role of science in society. Since its inception, the center has introduced new courses, internships, a speaker series, and student research programs, infusing the school’s traditional science courses with ethics and global health topics.

Senior biology major Kathryn Yoo heard about the center from a teaching assistant in a chemistry class and thought it would give her a chance to travel internationally. It did far more than that. “I used to get so wrapped up in talking science, science, science – I didn’t think about how it relates to other people, how it affects their lives,” says Yoo. “Now, I do.” It was the courses she took through the center, she says, that made the difference.

One such course, Science and the Common Good, examines the ethical, political, and religious implications of current scientific developments such as genome sequencing. Another course emphasizes how social, economic, and political forces influence sickness and treatments around the globe. Students like Yoo can also become fellows of the center, which involves intensive advising, a suite of specialized courses, and internship funding. Yoo spent five weeks in Peru working at a clinic for disabled children. “In the U.S., some of these kids would live at home and just go to physical therapy, but because of the structure of Peru’s health-care system, these kids have no choice but to live in this clinic,” she says. “It was shocking.”

Because of her experiences, Yoo now plans to pursue an MD-MPH dual degree rather than just an MD. “I now know it’s not just the medical side, but a lot of policy, that has an impact on health care. I want a background in that.”

Almost 200 miles west of Ursinus, a trio of professors at Juniata College, a liberal arts school in the small town of Huntingdon, Pennsylvania, has dedicated an entire arm of their HHMI-funded Genomics Leadership Initiative to science’s broad ethical, legal, and social implications – or ELSI, as they call the program.

ELSI thrives on breaking down academic silos at Juniata through interdisciplinary classes such as the Social History of Medicine, taught by a historian, and Doctors and Medicine in Literature, taught by James Roney, a professor of Russian literature and international studies, who co-leads ELSI. “A lot of these students are majors in the sciences who then do independent research, combining their scientific knowledge with work on ethics, global health, and the environment,” says Roney.

At all three colleges, the focus is not only on the students but also on the faculty. At Juniata, the ELSI program hosts well-attended faculty lunches where professors in different departments talk about issues related to genomics.

The program also hosted a January conference on teaching ELSI in the classroom. And over the last two summers, 12 faculty members attended an intensive two-week summer workshop that involved reading and discussing 10 books related to science and society, and developing genomics sections to include in courses across a range of disciplines.

“It can be too easy to sit in your own office and critique how scientific research might lead to social inequality,” says Roney. “Those of us who have been through these workshops take science much more seriously. I’m personally excited about this kind of model for what a liberal arts education can be, for both undergraduates and for faculty.”

At Allegheny this summer, the Global Health Studies program hosted 36 faculty members from other schools in the U.S. and abroad to discuss and share global health courses and curriculums. “We had to develop our major from scratch,” says Coates, “so we are always interested in sharing ideas with other folks and learning from them.”

More and more schools are clamoring for global health programs, according to Richards-Kortum, who regularly receives requests from colleges interested in starting their own. And they should, adds HHMI’s David Asai. “A program that teaches science or engineering and neglects the social implications is an incomplete education,” he says. “I’m glad to see these top schools engage and expose their students to the real world.”