Tiny Technologies, Giant Impact

The 2014 Lemelson-MIT Prize was awarded to a woman who boldly crosses disciplinary boundaries: a biomedical engineer who is also a physician and an entrepreneur. Her quest to improve global health through engineering and innovation focuses on liver disease and cancer.

By Meredith Holmes, SWE Contributor

Sangeeta N. Bhatia, M.D., Ph.D., is the 2014 recipient of the prestigious Lemelson-MIT Prize, which comes with a cash award of $500,000. The prize, given to an outstanding midcareer inventor, recognizes Dr. Bhatia's design and commercialization of miniaturized technologies that have a wide variety of medical applications, including tissue regeneration, diagnostics, stem cell differentiation, and drug delivery. Dr. Bhatia is the John J. and Dorothy Wilson Professor of Electrical Engineering and Computer Science and Institute for Medical Engineering and Science at MIT. She is also a Howard Hughes Medical Institute investigator and a member of the Koch Institute for Integrative Cancer Research at MIT. She is a senior associate at the Broad Institute and holds an appointment at Brigham and Women's Hospital.

The Lemelson-MIT Prize, which is 20 years old this year, honors inventors who seek to improve the world through technological innovation and who demonstrate a commitment to mentoring in science, technology, engineering, and mathematics. Dorothy Lemelson is chair of the Lemelson Foundation, named for her late husband, Jerome H. Lemelson, an inventor. Of this year's award she said, "Jerry always believed that it was crucial to highlight and encourage inventors dedicated to improving the human condition. Dr. Bhatia is a wonderful example of a woman who has used her brilliance, skill, and creativity to radically improve the detection and treatment of serious global health issues."

"I will donate some of the prize money to the MIT Society of Women Engineers. This organization runs fabulous outreach programs designed to keep young girls interested in the STEM fields. I also look forward to supporting a program for women's entrepreneurship in MIT's upcoming Innovation Initiative." — Sangeeta N. Bhatia, M.D., Ph.D., recipient of the prestigious Lemelson-MIT Prize

Impacting disease detection and treatment

As director of the Laboratory for Multiscale Regenerative Technologies, Dr. Bhatia leverages technologies from the materials manufacturing and semiconductor industries to impact liver disease and cancer. Dr. Bhatia and her multidisciplinary team of students and scientists have launched 10 companies and invented more than 70 products. Her lab has also developed a suite of communicating nanomaterials that can be used to interrogate, monitor, and treat cancer and other diseases.

Determined to improve the accuracy of disease detection, Dr. Bhatia has designed synthetic biomarkers that shed in urine and can be read in a simple paper-based urine test. The simplicity of this test has great potential — especially for cancer screening — in developing nations where medical equipment and trained personnel are often in short supply. Cancer deaths in these areas are on the rise, and the majority of patients who find their way to a medical facility already have an incurable disease. Dr. Bhatia is developing this platform for commercialization with support of the Koch Institute for Integrative Cancer Research and the Deshpande Center for Technological Innovation.

During her years as a medical student, Dr. Bhatia became fascinated with the liver — its crucial role in individual health and the global health problem of liver disease, which includes liver-stage human malaria. The liver has more than 500 functions, and plays a role in metabolism, detoxification, and digestion. Each year, more than 40,000 people die of liver failure in the United States alone, with more than 2 million deaths

estimated worldwide. Liver cells begin to lose function within hours of being removed from the body, and current tools to predict toxicity use dysfunctional human cells that don't accurately mimic a normally functioning liver.

To remedy these problems, Dr. Bhatia and her team have fabricated a micro liver device that can model human drug metabolism, predict drug toxicity, and interact with human pathogens. This device can also replicate the life cycle of liver-stage human malaria for drug screening, an application that is being developed further in collaboration with the Broad Institute with support from the Gates Foundation. Dr. Bhatia is co-founder of Hepregen, a company that markets the microliver devices to pharmaceutical companies to test new drugs.

The importance of role models and mentors

Dr. Bhatia received her B.S. from Brown University, her S.M. and Ph.D. from MIT, and an M.D. from Harvard Medical School. She did graduate and postdoctoral training at Massachusetts General Hospital, and before joining MIT, she held a tenured faculty position at the University of California, San Diego and worked at Pfizer, Genetics Institute, and ICI Pharmaceuticals. Describing the path she took to her present position, Dr. Bhatia said, "The story of how I became an engineer and a physician is sort of accidental and includes a lot of mentoring."

Dr. Bhatia's father was her first mentor. He saw she liked and excelled in math and science and thought she might like engineering. Articulating the outlook of many young girls, Dr. Bhatia recalled, "I had no conception of what the profession was, what the work flow was, what you did, or how you contributed to society." She also liked biology, and her father, having read about the emerging field of biomedical engineering, arranged for her to visit a lab at MIT, where a mechanical engineer was investigating the effects of ultrasound on tumors. "That really captured my imagination," Dr. Bhatia said. "The idea that you could build instruments to impact human health."

As an undergraduate, she explored the many dimensions of biomedical engineering, and in her junior year, worked in a lab that researched nerve regeneration using polymer materials. A staff physician suggested she get her Ph.D. "This was not in my plan," she admitted. "I was going to get an engineering degree and work in industry."

Dr. Bhatia's team includes chemical, electrical, biomedical, and mechanical engineers, as well as physicists, chemists, and physicians. They all work on the same two problems: liver disease and cancer.

She didn't act on the suggestion right away, but she kept it in mind. Dr. Bhatia eventually entered the graduate engineering program at MIT, which has a joint program with Harvard Medical School. "I fell in love with the human body, taking those classes," she said. She completed her M.D., and then, following another professor's advice, applied for a faculty position at MIT.

"Biomedical engineering turned out to be the most fabulous profession; it's full of creativity," she said. "But it was pretty late in the game when I discovered this was my dream job." Dr. Bhatia believes mentoring is important for women in STEM fields. Pointing out that all her mentors were men, however, and none identified themselves as mentors when they gave her career advice and opened doors for her, she said, "What's important is for someone to see your potential, take an interest in your future, and care about the outcome."

Also recognized for her unique approach to research, Dr. Bhatia is an exceptional lab director. Said Josh Schuler, executive director of the Lemelson-MIT Program, "Dr. Bhatia has amplified the impact of her inventions through the collaboration of diverse teams that tackle complex problems." Dr. Bhatia's team includes chemical, electrical, biomedical, and mechanical engineers, as well as physicists, chemists, and physicians. They all work on the same two problems: liver disease and cancer. "How people march through this challenge depends on their skill set. If you're a chemist, you might say, 'I could make a new molecule that will target a cancer cell.' If you're an electrical engineer, you might say, 'I can fabricate a device that makes patterns of cells on a substrate.'"

To encourage creativity, Dr. Bhatia tells her team members to spend 20 percent of their time on their own projects. She wants to preserve the fun and creativity of science, since research is hard, and experiments often fail. She observed, "Invention in the medical space in general takes a very long time. Fourteen years elapsed between the aha moment in the lab when I figured out we could fabricate livers to the first time data generated by the company was used as part of an FDA decision for clinical toxicity."

Declaring that SWE is near and dear to her heart, Dr. Bhatia has pledged a portion of the Lemelson-MIT prize money to "Keys to Empowering Youth (KEY)," an outreach project she helped start, and which is run by the MIT SWE collegiate section. "I was a member when I was at Brown University," she said, "and one of the first things I did when I arrived at MIT was volunteer to be the section advisor." KEY brings middle-school girls, ages 11 to 13, to MIT for a daylong workshop that introduces them to engineering. They meet young women pursuing engineering careers and are encouraged to ask them questions about the field and about their aspirations.

"We need a lot of institutional change to protect against bias, whether it's unconscious bias or frank discrimination," said Dr. Bhatia, "but role models are also important. That's one reason I'm so pleased about receiving the award. I hope my visibility will show lots of young girls what a great career this is." ■