# UndergraduateResearch | Amber Loree

## People with chronic lung degeneration may one day breathe easier, thanks in part to this Pitt student's research

This is the fourth in a series of *Pitt Chronicle* articles profiling outstanding University of Pittsburgh undergraduate researchers

By Daniel Bates

Pitt bioengineering major Amber Loree (center) with Professor William Federspiel and Ph.D. candidate Kristie Burgess.

Like most Pitt students, Amber Loree will breathe a bit easier when she completes her degree, which she is scheduled to do in April.

*Un*like most students, Loree has reason to believe that work she has done at Pitt will one day make other people—those suffering from chronic lung degeneration—breathe easier, too.

An articulate, outgoing bioengineering major with a self-professed penchant for academic challenges, Loree has interned for the past year in the University's McGowan Institute for Regenerative Medicine (MIRM) with William Federspiel, an entrepreneurially minded Pitt professor of chemical engineering, and his doctoral student, Kristie Burgess.

Together, they are developing and testing small, polymer-based artificial lung modules with tiny pathways for diffusing blood, oxygen, and carbon dioxide. Burgess, who received funding from the Whitaker Foundation for this five-year dissertation project, is leading the research effort, with guidance from Federspiel and Pitt surgery professor William Wagner.

It's all part of a grander, entrepreneurial research endeavor, says Federspiel, who asserts that he always is looking for the next entrepreneurial opportunity. He directs MIRM's Artificial Lung Laboratory and cofounded a local life-sciences start-up company, ALung Technologies, which seeks to develop a patient ventilation solution with proprietary gas-exchange and catheter devices.

In this latest research effort, doctoral student Burgess—with considerable help from Loree, Federspiel points out—is pushing to create not just a new device but an entirely new technology platform, including fabrication processes on which to develop artificial lung and other respiratory-assist devices outside of the human body that will work as well as, or perhaps even *better* than, natural lungs. Federspiel hopes to attract National Institutes of Health funding for this project.

"I've had this idea for a long time," Federspiel says of the research, which involves new microfabrication processes and tissue-engineering technologies. "Once we demonstrate that the platform itself works, then we'll identify a company that wants to do the real engineering to develop new respiratory-assist devices."

Loree, to her delight, has found herself in the middle of this groundbreaking innovation-development effort.

"I never even imagined doing stuff like this," says Loree, who originally enrolled in Pitt's School of Engineering to pursue an industrial engineering degree. She chose industrial engineering, she says, because, as a high school student in her small hometown of Winterville, Ohio, she loved mathematics.

But during Loree's freshman year at Pitt, her grandfather successfully underwent open-heart surgery. This close brush with the life-and-death business of saving human organs inspired Loree to change her major to bioengineering, with a concentration in artificial organs. Bioengineering department chair Harvey Borovetz subsequently put her in touch with Federspiel and Burgess, facilitating an internship that would change Loree's career path.

"It's more physics and science" than math, she says of her new major. "But I really like to challenge myself, and I had heard that it's really challenging in bioengineering."

Her earlier training in engineering would come in handy, however, as Loree helped Burgess to design and fabricate layers of thin but three-dimensional, difficult-to-manufacture lung modules out of polydimethylsiloxane. ("We just call it PDMS," Loree says of the rubbery polymer, which is known for its high gas permeance, or ability to handle gases as they pass through its pathways.)

The challenge, Loree says, has been in trying to manufacture modules that are thinner and more efficient, with pathways that don't leak. The biggest lesson she's learned: patience.

The process, known as soft lithography, begins with a flat silicon disc that serves, in essence, as a mold for the PDMS. The disc, which is etched with a series of microgrooves, then is placed in a so-called spin coater, where the liquefied polymer is applied. The coater uses centrifugal force to spread the polymer thinly and evenly onto the disc as it spins at predetermined speeds. The faster the speed, the thinner the coating.

When dry, the thin layers—less than 100 microns thick so far (roughly the thickness of a human hair)—are peeled from the disc, stacked systematically, and then fused together, forming a layered membrane with tiny oxygen and blood passageways that are created by the microgrooves. To complete the process, Burgess seeds those tiny passageways with endothelial cells (cells that make up the lining of blood vessels), which are designed to make the artificial modules more biocompatible with the human body.

In addition to helping with the modules' fabrication, Loree's job has been to test those stacked membranes for gas permeance, considering such variables as polymer thickness, size of the grooves, and number of layers and passageways needed to adequately pump oxygen, carbon dioxide, and blood through them.

"It was hard to fabricate them," Loree says of the thin-layered modules. "It was such a long process, sometimes four to six hours at a time, and then they wouldn't work. Sometimes it took at least four tries to manufacture a working module. It was disappointing sometimes."

Still, the trial-and-error experiments have paid off. Loree, Burgess, and Federspiel have managed to fabricate working modules with at least six polymer layers and have successfully produced even-thinner layers using a spin coater speed of at least 1,000 rotations per minute, up from 500 r.p.m. in earlier experiments. Eventually, the team hopes to produce working modules that are many layers thick and which basically will serve as artificial lungs providing long-term gas exchange for patients with deteriorating lungs. This process, however, still could require a number of years of research, Federspiel acknowledges.

Loree witnesses almost daily the kinds of health problems that might be solved with the lung modules being developed at MIRM. She works part-time with patients at Children's Hospital of Pittsburgh, serving as an ECMO technician (ECMO stands for extra-corporeal membrane oxygenation, which assists in gas exchange for patients with lung problems).

When she's not in the lab or working at Children's, Loree hones her business skills as business manager of the University's Biomedical Engineering Society chapter and as a footwear sales associate at Sears. But her professional passion remains in artificial organ research and development.

"Just watching this [MIRM lung-related research] develop, I feel that this really could have a great impact on society," Loree says.

"Amber has done a great job," says Burgess, who expects to complete her doctorate in bioengineering in April. "She's always willing to do extra and learn new things."

Federspiel likewise praises Loree.

"It was such a challenging project that we needed someone who could figure out things on her own," Federspiel says. "And it's also a good opportunity for graduate students such as Kristie to learn the mentoring process. In Amber's case, Kristie trained her early on, and Amber was very good. It was a good investment."