A wearable sensor that tracks COVID-19 symptoms and recovery. A wireless, flexible respiratory monitor for patients with sleep apnea. An implant that senses fatal levels of ingested opioids and then delivers life-saving naloxone.

These are just a few of the biocompatible electronic, photonic, and microfluidic technologies developed for the human body by scientists and engineers in the Querrey Simpson Institute for Bioelectronics (QSB).

With broad applications across medicine, rehabilitation, and sports, QSB supports the entire ecosystem of translational science—from fundamental materials development to device and component engineering to system prototyping—all under one roof. These systems are then deployed in clinical research settings within the institute’s medical partners, including Northwestern University Feinberg School of Medicine and Shirley Ryan AbilityLab.

“We designed the lab to provide an educational experience for the students that’s almost impossible to gain any other way,” says John Rogers, Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering, and Neurological Surgery and QSB director. “They gain an understanding of all steps in the process, and ultimately, how their work impacts patients.”

Supported by a gift from Northwestern University trustee Kimberly K. Querrey (’24 P) and the late Louis A. Simpson ’58 (’96 P), who joined the Board of Trustees in 2006 and became a life trustee in 2010, the two-floor, 24-hour facility in the Technological Institute's AB wing features a wealth of state-of-the-art research spaces, testing rigs, and manufacturing tools.

Special thanks to Anthony Banks, director of engineering research at the Querrey Simpson Institute for Bioelectronics, for supporting contributions on this story.
QSIB’s third-floor lab is configured to support new device development, from initial concepts to scaled prototype manufacturing.

1. PUBLIC ENTRYWAY QSIB’s museum-like entrance displays some of its biggest achievements, from a skin-mounted microfluidic device for sweat analysis to a wireless monitoring sensor worn by premature babies in the neonatal intensive care unit.

2. PROTOTYPING AREA Overlooking the AB wing atrium, students populate the circuits in their prototype electronic devices using microscopes and soldering equipment. Overhanging fume extractors capture rising solder smoke. Project benches—each devoted to specific research—provide students a dedicated space to iterate their devices.

3. CYCLIC TESTER To test the structural integrity of implanted bioelectronic devices—such as the lab’s battery-free, dissolvable transient pacemaker—students turn to a cyclic tester, which recreates natural conditions inside the human body. Device prototypes are submerged into a saline solution—heated to the same temperature as the body’s natural biofluids—then twisted and contorted to replicate the changes and stresses that come with human movement.

4. MANUFACTURING AREA Laser cutters, milling machines, and 3D printers support scaled manufacturing techniques that combine different components developed in the lab into fully realized devices that can be tested in clinical settings.

The space’s flagship equipment is a Manncorp Autotronik surface-mount technology (SMT) component placement system (4A), a robotic assembly tool that applies surface-mount technologies onto printed circuit boards. The machine can dispense more than 5,000 SMT components per hour, with the smallest components just 0.2 by 0.4 millimeters in size.

Photography by Jason Brown
QSIB’s fourth-floor space supports new materials development and processing and fabrication for individual electronic device components. When complete, these materials transition to the third floor where they are further developed and combined to create functioning systems.

5. ISO 6 CLEANROOM QSIB’s cleanroom features three sections devoted to semiconductor materials development: a micro-lithography room (5A), which uses light-based tools to define geometric patterns on thin film samples (blue light is filtered to avoid contaminating the samples, giving the space a yellow appearance); a wet chemistry lab (5B), used to etch and clean the patterns; and a deposition room, where metals are placed onto the finished sample.

6. FLUIDICS LABORATORY Students use microfluidics technologies, mechanical instrumentation, and chemical synthesis tools, such as colorimetric assays, to build device components for systems that aid in drug delivery or sweat analysis. Past projects in this area have included a personalized system for nutrient balance, composed of a skin-interfaced microfluidic sensor for monitoring essential nutrients in sweat and an integrated transdermal patch that delivers needed vitamins through the skin.

7. RADIO FREQUENCY DEVICE TESTING LABORATORY Also known as a Faraday cage, this room blocks out all electromagnetic signals, providing an interference-free space to test the power output of wireless electronic devices developed in the lab. This necessary step ensures devices meet Federal Communications Commission regulations before they are tested on patients in hospitals.

8. ELECTRONICS LABORATORY Featuring four project-specific testing stations, this lab was designed for bench-testing electronic, thermal, flow, and temperature characteristics on devices with medical applications.

9. PROJECT LOCKERS Resembling elementary school cubbies, these storage spaces provide an efficient way for QSIB’s approximately 150 undergraduate, graduate, and postdoctoral students to hand off samples to collaborators or to restart their work when returning to the lab.

ALEX GERAGE

Photography by Jason Brown