Tissue Engineering

Spotlight on Wake Forest Institute for Regenerative Medicine

From engineering replacement livers and muscle to developing a cell therapy for diabetes, SBES students assigned to the Wake Forest Institute for Regenerative Medicine (WFIRM) in Winston-Salem, N.C., collaborate on projects that could dramatically affect health care. Regenerative medicine – the science of replacing or repairing damaged tissues – has been called the next evolution of medicine and offers the promise of curing, rather than merely treating, many diseases.

Dr. Emmanuel Opara

Students in the SBES Cell and Tissue Engineering Track work with SBES/WFIRM faculty members and make contributions in areas such as biomechanics, fluid flow, and material science. Some current projects, and the faculty members and students involved, include:

- Lab-engineered replacement muscle has the potential to help patients with muscle defects due to cleft lip and palate and traumatic injuries or surgery. In animal studies, engineered muscle constructs that were "exercised" on a computer-controlled device before implantation resulted in significant functional recovery. (George Christ, Ph.D.; Hannah Baker, B.S.)

- For large segments of lab-grown muscle tissue to function after implantation, it must be stimulated by the body's nerves. But, it takes time for existing nerves to grow to meet the new tissue and form the neuro-muscular junction. To keep the tissue functioning in the meantime, scientists are exploring a pharmacologic agent to "trick" the muscle into thinking it is innervated before it actually is. (George Christ, Ph.D.; John Scott, B.S.)

- Functional mini-livers have been engineered in the lab – a promising milestone in the quest to grow replacement livers for patients. The team is currently exploring various ways to optimize the bioengineering process to support self-organization of the liver tissue. (Shay Soker, Ph.D.; Emma Moran, B.S.)

- Institute researchers built the first anal sphincters that function in a lab setting, suggesting a potential future treatment for both fecal and urinary incontinence. Bioengineered with both muscle and nerve cells, the structure is "pre-wired" for placement in the body. Studies in animals are under way. (Khalil N Bitar, Ph.D., AGAF, and Shreya Raghavan, M.S.)

- Encapsulating insulin-producing cells inside a thin membrane may one day offer a new treatment for diabetes. With this strategy, donor cells could be used to provide insulin control for patients. The membrane allows oxygen and nutrients to enter the capsule, but would prevent a rejection response. (Emmanuel Opara, Ph.D.; J.P. McQuilling, B.S.)

- The ability to visualize the regenerative process in real time would allow scientist to optimize their techniques and build better tissues. A fiber-optic based imaging system developed at Virginia Tech is being applied to such bioengineered tissues as blood vessels. (Shay Soker, Ph.D., and Yong Xu, Ph.D.; Etai Sapoznik, B.S)

Bioprinting Wins Edison Award

A WFIRM team has won a gold Edison Award for innovations in bioprinting. The Edison Awards™, which recognize and honor innovative new products, services, and business leaders, are named after renowned inventor Thomas E. Edison.

The institute received the "Game Changer Award" in the science and medical category for two unique printers designed by institute scientists to print living cells and biomaterials rather than ink. The goal of the bioprinting projects is to print replacement tissues and organs for human patients.

Institute scientists were the first in the world to engineer an organ in the lab that was successfully implanted in patients. These original structures were built by hand using biomaterials and cells. In an effort to scale up this process, institute scientists designed a 3-D bioprinter that allows for the precise placement of cells and for multiple cell types to be printed. The 3-D printer is unique because it can print both gels and synthetic materials, which helps ensure structural integrity of tissues and organs.

The second printer designed by institute scientists is a bioprinter to print skin cells onto burn wounds. The impetus for the project is the need for improved care for patients with severe wounds, who often don't have enough healthy skin to harvest for skin grafts. With this system, a scanner will determine the surface dimensions and depth of the wound, and the data guides the printer to precisely place the appropriate type and number of cells.

Both printers are still in the research stage and not yet ready for use in patients. Institute scientists who are part of the bioprinter team are Anthony Atala, M.D., director, James Yoo, M.D., Ph.D., professor, Sang Jin Lee, Ph.D., assistant professor, John Jackson, Ph.D., associate professor, Hyun-Wook Kang, Ph.D., fellow, Aleksander Skardal, Ph.D., fellow, Carlos Kengla, Ph.D., student, and Mohammad Z. Albanna, Ph.D.