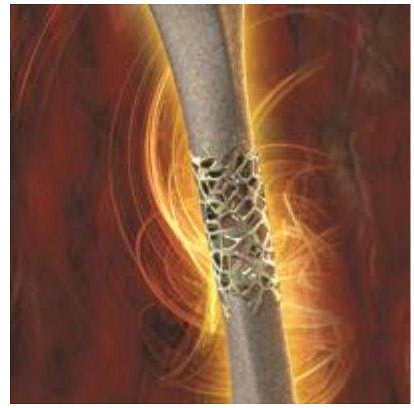
## Building Bridges



The CFTAH is all titanium, no human tissue. On the other end of the spectrum, researchers are working on coaxing human tissue to rebuild damaged bone, a critical need for soldiers and civilians. In the wars in Afghanistan and Iraq, an astonishing 93 percent of soldiers survive after being injured in explosions, thanks in part to better protective gear. But this means they're coming home with severe injuries that include missing sections of bone; injuries to the bones of the face; and gaps in blood vessels, muscles and tendons. To improve recovery, in 2008 the U.S. military funded two consortia — one headed by Rutgers University and Cleveland Clinic (RCCC) and a second headed by Wake Forest University and the University of Pittsburgh (WFPC) — under the umbrella of the Armed Forces Institute for Regenerative Medicine (AFIRM).

George Muschler, MD, Co-Director of the RCCC consortium and Vice Chairman of Orthopaedics and Rheumatology at Cleveland Clinic, is in charge of finding ways to bridge bone over a gap of more than 1 inch. "We're developing new methods for filling that defect with advanced biomaterials," he says. "We're looking very carefully at combinations of methods that have never been looked at before. With several academic centers working together with industry partners, we can mix, match and compare technologies to find what works best for our injured service members, as well as civilians with these severe injuries." For example, AFIRM researchers are able to select the most promising bone scaffolds and the best methods for harvesting and processing bone cells from labs across the country.

Right now, the common way to fix a large bone gap is to screw in metal rods, which can cause scarring and bleeding, and possibly infection, pain and deformity. So last year, AFIRM researchers tested and compared the top new technologies for scaffolds made of polymers with a fine, lacy architecture. "We're making them out of degradable materials," says Joachim Kohn, PhD, Board of Governors Professor of Chemistry and Chemical Biology at Rutgers University and Principal Investigator of the RCCC of AFIRM. "As the bone grows into this new scaffold and transforms it into living bone, the material actually disappears. At the end, the patient is not left with metal, not left with plastics. It's only his own regenerated bone."

In 2010 and 2011, AFIRM researchers will work to combine these materials with the best methods for getting living cells into the wound and for getting them to grow on the scaffold. To do this, they have developed methods for concentrating and selecting the bone-forming cells in bone marrow harvested from the patient's hip. Growth factors — natural proteins that encourage cells to graft into an area and grow — help these cells grow throughout the scaffold.

Researchers are also testing a protein called bone morphogenetic protein, which helps bone healing, and other molecules that help bone cells grow. The proteins are difficult to control, however, because they're soluble in water. "You put them in one place and they just migrate and move wherever the water flows in your body," explains Dr. Muschler. "Using them can be rather unpredictable."

To solve this problem, AFIRM researchers are looking at a technology called molecular surface design. Says Dr. Muschler, "This is a process of taking a molecule that we know has a very beneficial effect on our cells, and instead of just throwing it in and hoping that the molecule does what we want before it diffuses away, we tether it to the surface of the scaffold so that the molecule that we want stays exactly where we want it."

Dr. Muschler expects to test the new technologies in patients as early as 2012 or 2013. Then, both soldiers and civilians could benefit from the work of the three dozen organizations in AFIRM

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