Repairing bone with 3-D printing

April 17 2017, by Kathleen Haley

Inspired by the structure of natural bone that provides a porous load-bearing scaffold to house soft biological cells, Assistant Professor Pranav Soman and his research team are using 3D printing to create polymer scaffolding that can be filled with bone-forming human cells. Credit: Syracuse University

Metallic implants—widely used clinically to replace diseased or damaged bone tissue—are not biodegradable and stay in the human body until removed surgically. The implants may also have problems with corrosion and could cause a negative reaction with the immune system. As a result, new polymer-based biodegradable implants are being developed to provide a needed alternative to metal.

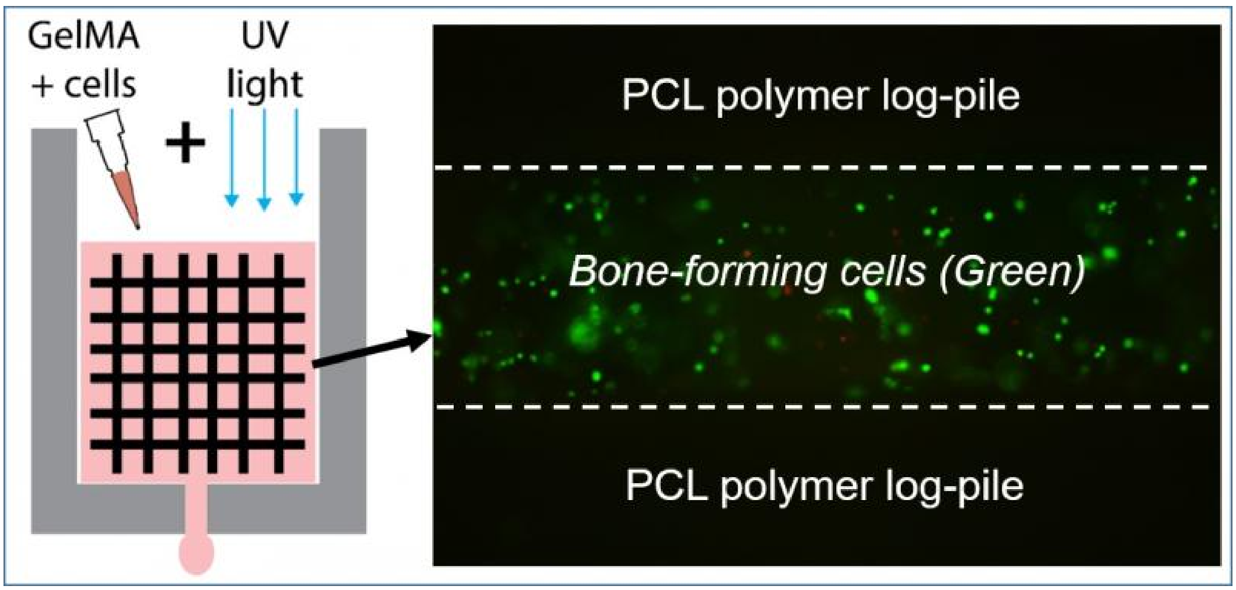
Inspired by the structure of natural bone that provides a porous load-bearing scaffold to house soft biological cells, Assistant Professor Pranav Soman and his research team are using 3-D printing to create polymer scaffolding that can be filled with bone-forming human cells.

The polymer scaffold provides the initial support structure, while the cells eventually fill in and develop into bone, replacing the polymer that slowly degrades, providing a more natural replacement for the bone.

Soman and his team's work, titled "Developing 3-D scaffolds in the field of tissue engineering to treat complex bone defects," was published last year in the journal *3-D Printing and Additive Manufacturing*. The paper's first author is Lucas Albrecht '14, a graduate student in Soman's lab, and it is co-authored with Soman and Stephen Sawyer, a doctoral student in Soman's lab.

"We can use 3-D printing to create complex bone formations using porous log pile structures," says Soman, of the Department of Biomedical and Chemical Engineering in the College of Engineering and Computer Science.

The polymer component used in this work is called PCL, a Food and Drug Administration-approved biomaterial. This polymer is processed at a high temperature and then filled with gelatin laden with bone-forming cells that can deposit bone mineral or hydroxyapatite within the gelatin matrix. Once filled and exposed to ultraviolet light, the hybrid structure can both support the load and sustain the growth of the cells.



Assistant Professor Pranav Soman and his research team are using 3D printing to create polymer scaffolding that can be filled with bone-forming human cells. An FDA-approved polymer is processed at a high temperature and then filled with gelatin laden with bone-forming cells that can deposit bone mineral or hydroxyapatite within the gelatin matrix. Once filled and exposed to ultraviolet light, the hybrid structure can both support the load and sustain the growth of the cells. Credit: Syracuse University

"With 3-D printing, you can basically put this in and forget about it because the structural PCL polymer will degrade in about a year and the cells stuck between the PCL logpiles remain," says Soman, who received departmental funding for the research. "They will produce more and more bone and fill the whole gap, and you won't be able to identify between what is the surrounding bone and the new bone created by the cells."

Currently the team is collaborating with Jason Horton, of SUNY Upstate Medical University's Institute of Human Performance, to evaluate the effectiveness of this approach within model animals, such as mice.

"With this work we have the ability to merge the hard polymer and soft cellular components," he says. "In the future, patient-specific stem cells can be also used to generate new bone."

Ultimately, the goal of Soman's research would be the ability to fit patients with polymer-cellular bone implants. It might be especially beneficial for children, since the implants would allow for growth, unlike metallic implants.

Soman credits the department funding and having his lab housed in the Syracuse Biomaterials Institute as critical to being able to do the experimental work with extensive available infrastructure.

"It is a great institute because it allows a shared common space for faculty of varied expertise, focus areas, and instrument-needs to work together, and solve multidisciplinary challenges in the field of bone tissue engineering," Soman says.

Provided by Syracuse University