A NICE Way to Save Lives

About 115,000 people in the United States are in need of an organ transplant. These individuals are suffering from organ failure caused by conditions ranging from heart disease to cystic fibrosis, and only a healthy organ offers a chance at life. The problem is, there aren't enough organ donors to meet the demand. On average, twenty people die each day waiting for an organ transplant. Wouldn't it be great if we had a way to grow new organs that could replace damaged or diseased ones?

Scientists are trying to do just that, but making an organ is a lot more complicated than getting cells to divide in a Petri dish. One of the challenges is that you need to provide nutrients and support the cells as they grow and divide in three dimensions. To do that, you need a scaffold, or a framework, with all the right properties such as shape, size, strength, and elasticity.

These scaffolds are the three dimensional, building blocks upon which doctors can grow living tissues. As shown in **Figure 1**, The scientists soak the scaffolds in liquid full of living cells. The cells get absorbed by the scaffold material, just like a sponge or paper towel absorbs water. Then as the cells grow and replicate, they fill in the spaces in the material. The scaffolds help the cells form tissue that is in the correct shape for a liver or a lung or whatever organ is needed. To be effective, the scaffold has to be strong enough to support the cell growth, but flexible enough to achieve many shapes.

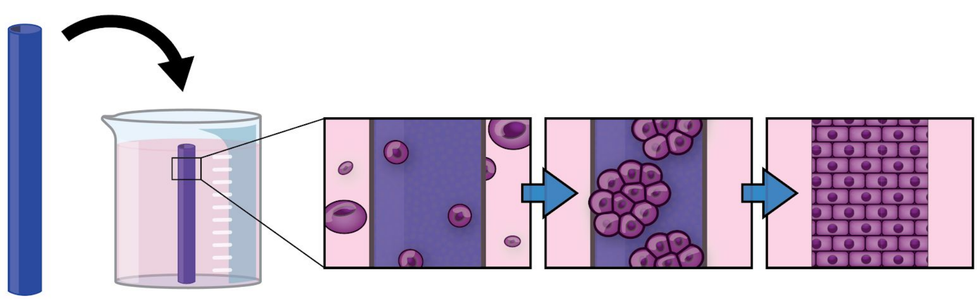

Figure 1. **Bioprinting Polymer Structures to Support Cell Growth.** A biological scaffold is placed in a solution with cells. The cells attach to the scaffold and grow into the shape of the scaffold. The scaffold can then disintegrate, leaving tissue in the original shape of the scaffold.

Researchers in biology, chemistry, physics, and engineering have come together to help tackle the complex problem of organ scaffolds. Their solution? Use specialized 3D printing technology to make scaffolds out of polymer inks.

While biologists provide knowledge of the human body and cells, and physicists and engineers know how to work with 3D printers, it is up to chemists to design the chemical structures and materials used in the 3D printer ink. Obviously, a bit more care has to go into designing the inks used for organ scaffolds than inks for a pen! Chemists must use their knowledge of chemical bonds to create materials that have the strength, flexibility, and characteristics required for their delicate and sensitive functions. Easier said than done!

In 2018, a team of chemists at Texas A&M University reported success using a new kind of polymer ink called a **NICE bioink**. NICE stands for Nanoengineered Ionic Covalent Entanglement. This long name just means that NICE is a type of ink that combines really tiny particles for structural support with two specifically designed polymers, each with a different type of crosslink. When all three materials are combined together, the resulting material is much stronger than either of the polymers that make it up—the new material is truly greater than the sum of its parts.

This new flexible ink can reach heights of 3 cm! This may not seem like a lot, but before this research, polymer inks could only reach a height of 1 cm, which isn't tall enough to support the growth of many of the organs in the human body. With this 300% increase in height, scientists and doctors can now print stronger, taller tissues, like a piece of a liver! But organs are also squishy, so the flexibility of NICE bioink makes it possible for these strong structures to feel flexible and resilient. For example, reach up and feel how strong yet flexible your ear is—that is exactly what these researchers were able to print, a human ear! With this technology, biologists, chemists, and engineers will find a way to make functional organs so that more people will get transplants faster and more lives will be saved.

References

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BiteScientist Profiles

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