This 3D-printed ‘living ink’ could someday help with skin replacements

Tomorrow’s replacement skin could be 3D printed from a new ink embedded with living bacteria.

Bacteria are able to do everything from breaking down toxins to synthesizing vitamins. When they move, they create strands of a material called cellulose that is useful for wound patches and other medical applications. Until now, bacterial cellulose could only be grown on a flat surface — and few parts of our body are perfectly flat. In a paper published today in *Science Advances*, researchers created a special ink that contains these living bacteria. Because it is an ink, it can be used to 3D print in shapes — including a T-shirt, a face, and circles — and not just flat sheets.

Bacterial cellulose is free of debris, holds a lot of water, and has a soothing effect once it’s applied on wounds. Because it’s a natural material, our body is unlikely to reject it, so it has many potential applications for creating skin transplants, biosensors, or tissue envelopes to carry and protect organs before transplanting them.

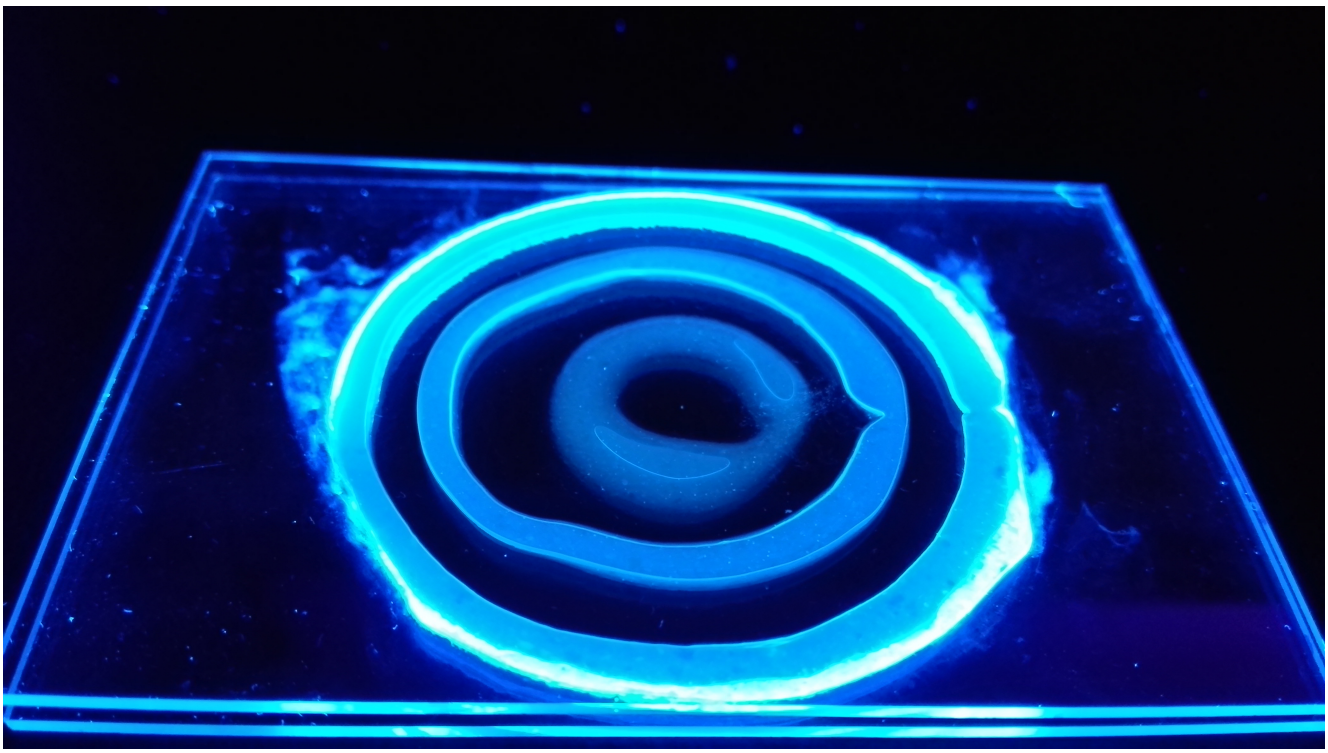
The tricky part is how the cellulose is made. These harmless bacteria produce strands of cellulose to help propel themselves forward. So, they need to be mobile to create the material, but this movement makes 3D printing difficult, says study co-author Manuel Schaffner, a materials scientist at ETH Zurich. To 3D print something, you need ink that flows a certain way to get it through the printing nozzle, and making ink the right thickness can freeze the bacteria.

The team needed to create a material that kept the bacteria alive and mobile, but also had the right properties for

printing. Their special “living ink” includes sugars that bacteria can use as nutrients so they stay alive and continue producing cellulose. It also incorporates a type of tiny glass beads that break apart and let the entire ink flow through a printing nozzle before solidifying again. So most of the cellulose is actually produced on the surface of the printed object. (Once the ink has been printed, the bacteria can move around again and create more food from oxygen and the environment.)

Now the team is able to make other shapes other than the usual flat sheets, says co-author Patrick Rühs, who also researchers complex materials at ETH Zurich. These shapes include a skin film, a T-shirt, and even cellulose film on top of a silicone face mold.

3D-printed T-shirt grown by cellulose-producing bacteria. Photo by Manuel Schaffner and Patrick A. Rühs



3D-printed circles with embedded cellulose-producing bacteria. Photo by Manuel Schaffner and Patrick A. Rühs

There’s a lot of potential here for personalized skin or scaffolds that fit people perfectly. And the material should be easy to scale, says Schaffner. The ink components are cheap, and culturing the various strains of bacteria is fairly straightforward. The team is now working on potential improvements, says Rühs, such as creating inks with different properties. But if one day they perfect their method, our bacteria-filled bodies might become even more merged with these invisible organisms.