

# A 3D ink made of living cells for creating living structures

November 27 2021, by Bob Yirka

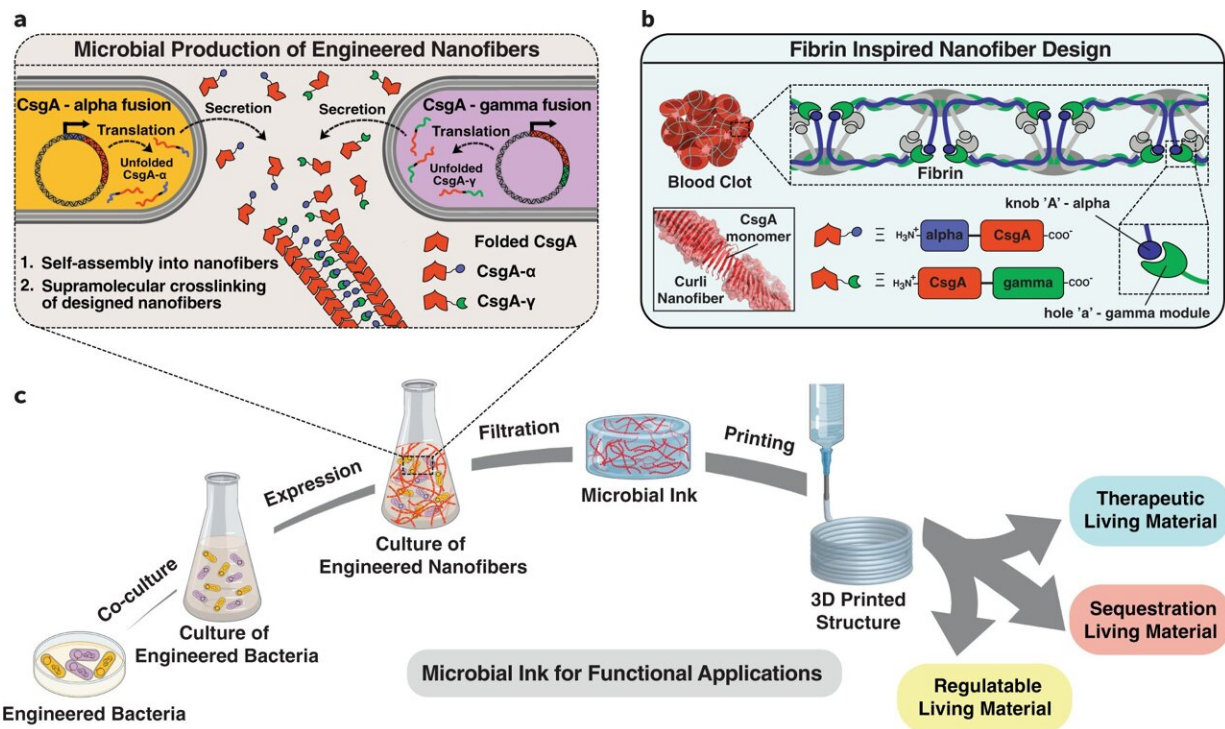


Fig. 1: Schematics of the design strategy, production, and functional applications of microbial ink. a *E. coli* was genetically engineered to produce microbial ink by fusing  $\alpha$  (knob) and  $\gamma$  (hole) protein domains, derived from fibrin to the main structural component of curli nanofibers, CsgA. Upon secretion, the CsgA- $\alpha$  and CsgA- $\gamma$  monomers self-assemble into nanofibers crosslinked by the knob-hole binding interaction. b The knob and hole domains are derived from fibrin, where they play a key role in supramolecular polymerization during blood clot formation. c The protocol to produce microbial ink from the engineered protein nanofibers involves standard bacterial culture, limited processing steps, and no addition of exogenous polymers. Microbial ink was 3D printed to obtain

functional living materials. Credit: DOI: 10.1038/s41467-021-26791-x

A team of researchers from Harvard University and Brigham and Women's Hospital, Harvard Medical School, has developed a type of living ink that can be used to print living materials. In their paper published in the journal *Nature Communications*, the group describes how they made their ink and possible uses for it.

For several years, microbial engineers have been working to develop a means to create living materials for use in a wide variety of applications such as medical devices. But getting such materials to conform to desired 3D structures has proven to be a daunting task. In this new effort, the researchers have taken a new approach to tackling the problem—engineering *Escherichia coli* to produce a product that can be used as the basis for an ink for use in a 3D printer.

The work began by bioengineering the bacteria to produce living nanofibers. The researchers then bundled the fibers and added other ingredients to produce a type of living ink that could be used in a conventional 3D printer. Once they found the concept viable, the team bioengineered other microbes to produce other types of living fibers or materials and added them to the ink. They then used the ink to print 3D objects that had living components. One was a material that secreted azurin—an anticancer drug—when stimulated by certain chemicals. Another was a material that sequestered Bisphenol A (a toxin that has found its way into the environment) without assistance from other chemicals or devices.

The researchers believe that their concept suggests that producing such inks could be a self-creating proposition. Engineering could be added to the microbes to push them to produce carbon copies of themselves—the

ink could literally be grown in a jar. They also state that it appears possible that the technique could be used to print renewable building [materials](#) that would not only grow but could self heal—a possible approach to building self-sustaining homes here on Earth, or on the moon or on Mars.

**More information:** Anna M. Duraj-Thatte et al, Programmable microbial ink for 3D printing of living materials produced from genetically engineered protein nanofibers, *Nature Communications* (2021). [DOI: 10.1038/s41467-021-26791-x](https://doi.org/10.1038/s41467-021-26791-x)

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