INSPIRING **SCIENCE MAGAZINE** FOR GIRLS. FUN READING FOR ALL. **WINTER 2023**

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Turning Pixels to Reality:
The Dawn of 3D Avatars

Sascha von Meier

Powering Smart Grids for a Smarter Future

The Astonishing World of Animal Regeneration

How was the world's first photograph made?

Bio-Printing: the Race to Save Lives

Imagine painting with body cells! Dip your brush in bone ink and paint bones. Or dab some muscle paint on canvas and watch it move. Paint nerves, veins, skin and more, until you've finished your masterpiece. Voila!

That's the basic idea behind bio-printing, a very real and fast-growing area of science.

Human tissue, even some organs, can be printed with a "bio-printer"—a printer that builds three-dimensional (3D) body parts using living cells. 3D bio-printing is one of the hottest areas of medical progress because of its many creative and important uses. One surgeon saved the lives of three children by bio-printing bladders for them. But it's not as straightforward as it sounds, and there are limits to what can be printed. Bio-printing is improving quickly, but not fast enough for some.

Why is 3D bio-printing needed?

Millions of people worldwide need new kidneys, livers, hearts, and lungs because their own organs stopped working. The wait is long, and many people don't survive it. Only about 144,000 organs per year are donated and transplanted around the world, so bio-printed organs are desperately needed.

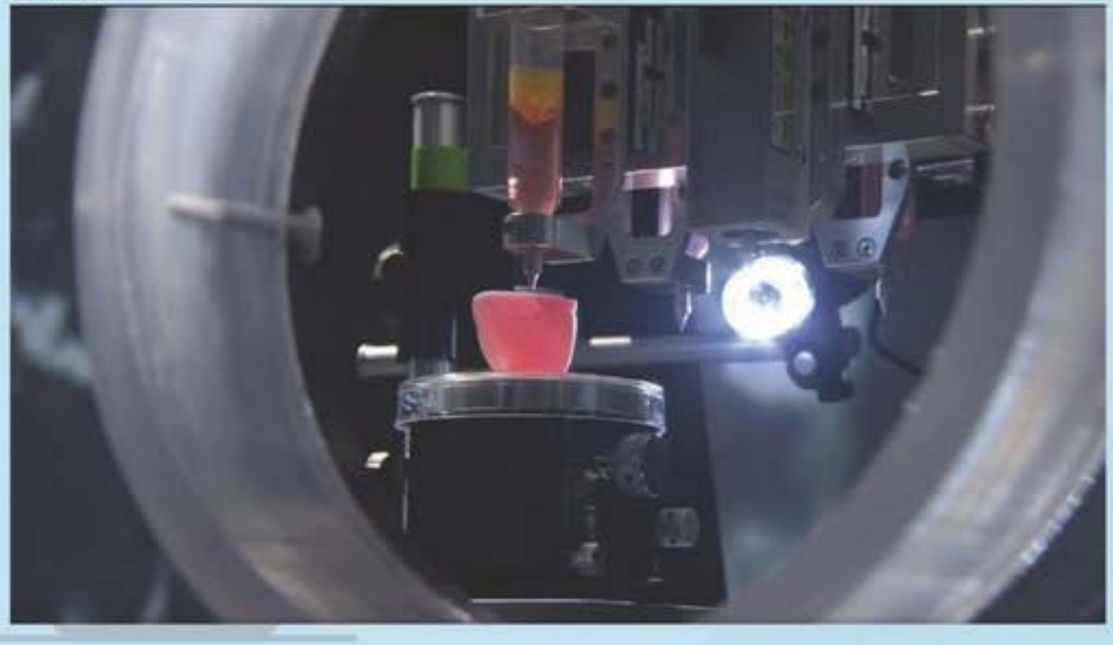
Bio-printing can also be used to explore causes and cures for diseases. Heart tissue, for example, can be bio-printed, then tested to see what damages hearts and what heals them. Sometimes, the diseased cells of patients are printed right into the bio-tissue, so cures can be individually customized. Bio-printed tissue can replace the use of test animals in disease research.

How are bio-materials 3D-printed?

To 3D bio-print, you need (1) a 3D pattern of the tissue or organ, scanned and uploaded to the bio-printer's computer, (2) "bio-ink," a slurry the consistency of cake frosting, made of different kinds of cells suspended in a watery gel that keeps them alive (the cells are often taken from the person that will receive the bio-printed organ so their body doesn't reject it), and (3) a 3D printer that prints the cells, layer by layer, into a framework called a "scaffold" that maintains the tissue's shape during printing. As they print, bio-printers must place different cell types exactly correctly relative to each other, so they interact just like they do in naturally-grown tissues. Then the bio-material "cures" in a special chamber.

What progress has been made in 3D bio-printing?

Bio-printing technology is making enormous progress, but most of its success is still in the lab. Some body parts—an ear, a nose, leg bones—have been successfully bio-printed with cells from patients, and surgically implanted. Bladders have been bio-printed and implanted in ten people worldwide. Skin will soon be able to be bio-printed directly onto wounded patients. The most challenging organs are complex structures with networks of very fine veins and arteries, like hearts, livers, lungs, and brains. While prototypes and miniature versions of some of these have been printed, they haven't been approved for use in humans yet. Researchers are hard at work, but that milestone is probably still twenty years away. Meanwhile, tissues from these organs have been bio-printed for use in medical testing.

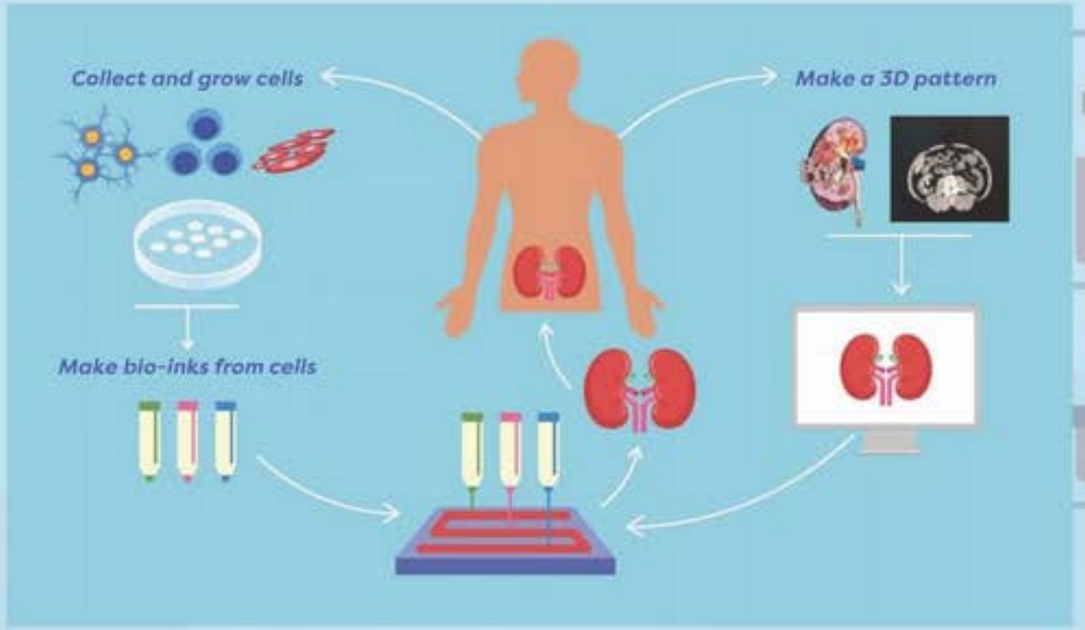


Anthony Atala "Printing a Human Kidney" TED Talk.

Woody Hoburg, astronaut on the International Space Station, changes the bio-ink on a 3D bio-printer that prints in micro-gravity.

Gravity can get in the way of printing the most complex body parts, as they collapse during printing. The solution? **Bio-printing in space!**

The International Space Station has a "Biofabrication Facility," currently printing a meniscus—a knee part—but the hope is to eventually print full human organs. Astronaut Woody Hoburg changed the bio-ink cartridge routinely during his recent stay in space. "Printing cardiac cells and blood vessels on Earth is extremely challenging because of gravity," says Woody. "Essentially, those structures just become a puddle under their own weight. So, it's a fascinating technology to explore in low Earth orbit, where we don't have those issues."



Credit: Anthony Atala

Credit: Woody Hoburg, NASA

Credit: National Institutes of Health

Inside a bioprinting lab where researchers print 3D models of human tissues and organs for drug screening.

The future of bio-printing

Medical needs are pushing the boundaries of bio-printing, but there are plenty of other uses. People are working on bio-printing leather and edible meat, for example. 3D bio-printing of plant tissue is not as advanced as animal tissue, but is making progress. And bio-printers are now increasingly common in neighborhood maker spaces, thanks to low-cost adaptations of standard 3D printers.

3D bio-printing is racing to improve the lives of people who need new organs and disease cures. But meanwhile, a world of opportunities for other uses of 3D bio-printing has opened. What would you create if you could paint with cells?