One step closer to bioengineered replacements for vessels and ducts

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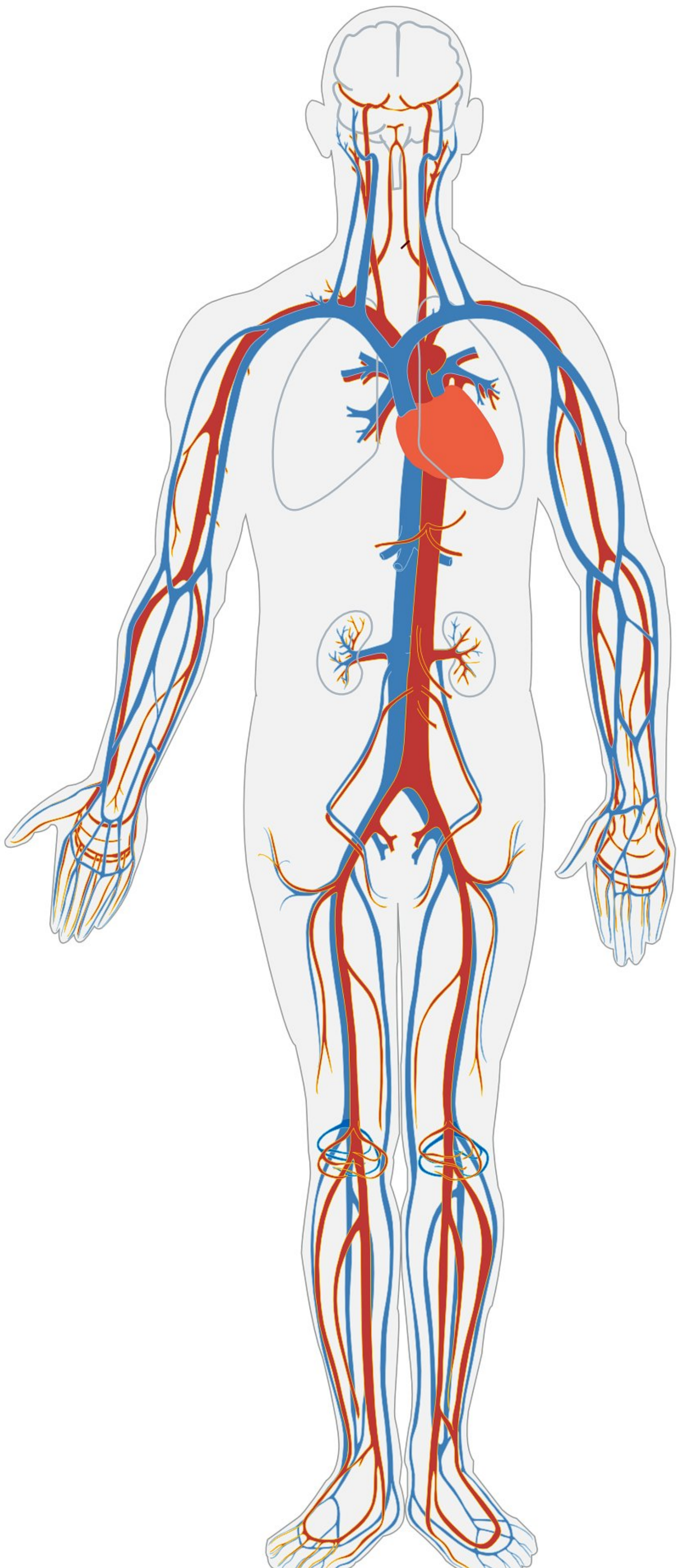

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A team of Brigham and Women's Hospital researchers have developed a way to bioprint tubular structures that better mimic native vessels and ducts in the body. The 3-D bioprinting technique allows fine-tuning of the printed tissues' properties, such as number of layers and ability to transport nutrients. These more complex tissues offer potentially viable replacements for damaged tissue. The team describes its new approach and results in a paper published on Aug. 23 in *Advanced Materials*.

"The vessels in the body are not uniform," said Yu Shrike Zhang, Ph.D., senior author on the study and an associate bioengineer in BWH's Department of Medicine. "This bioprinting method generates complex tubular structures that mimic those in the human system with higher fidelity than previous techniques."

Many disorders damage tubular tissues: arteritis, atherosclerosis and thrombosis damage blood vessels, while urothelial tissue can suffer inflammatory lesions and deleterious congenital anomalies.

To make the 3-D bioprinter's "ink," the researchers mixed the human cells with a hydrogel, a flexible structure composed of hydrophilic polymers. They optimized the chemistry of the hydrogel to allow the human cells to proliferate, or "seed," throughout the mixture.

Next, they filled the cartridge of a 3-D bioprinter with this bio-ink. They fitted the bioprinter with a custom nozzle that would allow them to continuously print tubular structures with up to three layers. Once the tubes were printed, the researchers demonstrated their ability to transport nutrients by perfusing fluids.

The researchers found that they could print tissues mimicking both vascular tissue and urothelial tissue. They mixed human urothelial and bladder smooth muscle cells with the hydrogel to form the urothelial tissue. To print the vascular tissue, they used a mixture of human endothelial cells, smooth muscle cells and the hydrogel.

The printed tubes had varying sizes, thicknesses and properties. According to Zhang, structural complexity of bioprinted tissue is critical to its viability as a replacement for native tissue. That's because natural tissues are complex. For instance, blood vessels are comprised of multiple layers, which in turn are made up of various cell types.

The team plans to continue preclinical studies to optimize the bio-ink composition and 3-D-printing parameters before testing for safety and effectiveness.

"We're currently optimizing the parameters and biomaterial even further," said Zhang. "Our goal is to create tubular structures with enough mechanical stability to sustain themselves in the body."

More information: Qingmeng Pi et al, Digitally Tunable Microfluidic Bioprinting of Multilayered Cannular Tissues, *Advanced Materials* (2018). DOI: 10.1002/adma.201706913

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