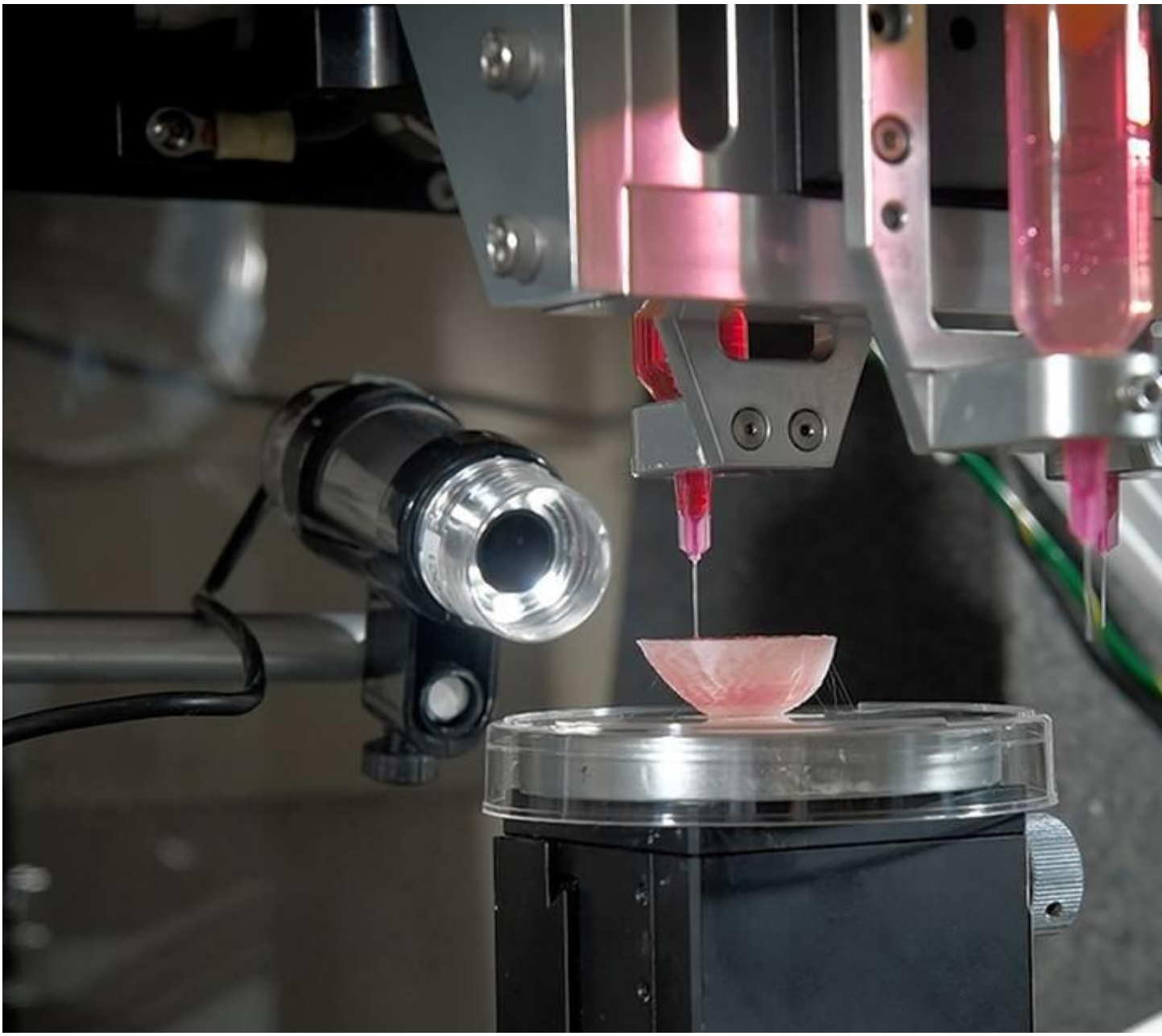
Medicine Shows Growing Potential to Repair and Regenerate Body Parts

Stem cells and 3-D printing hold promise for sight restoration and organ replacement



The Wake Forest Institute for Regenerative Medicine uses 3-D bio-printing to build tissue and, in some cases, entire organs for human transplantation. *ILLUSTRATION: WAKE FOREST BAPTIST HEALTH*

By
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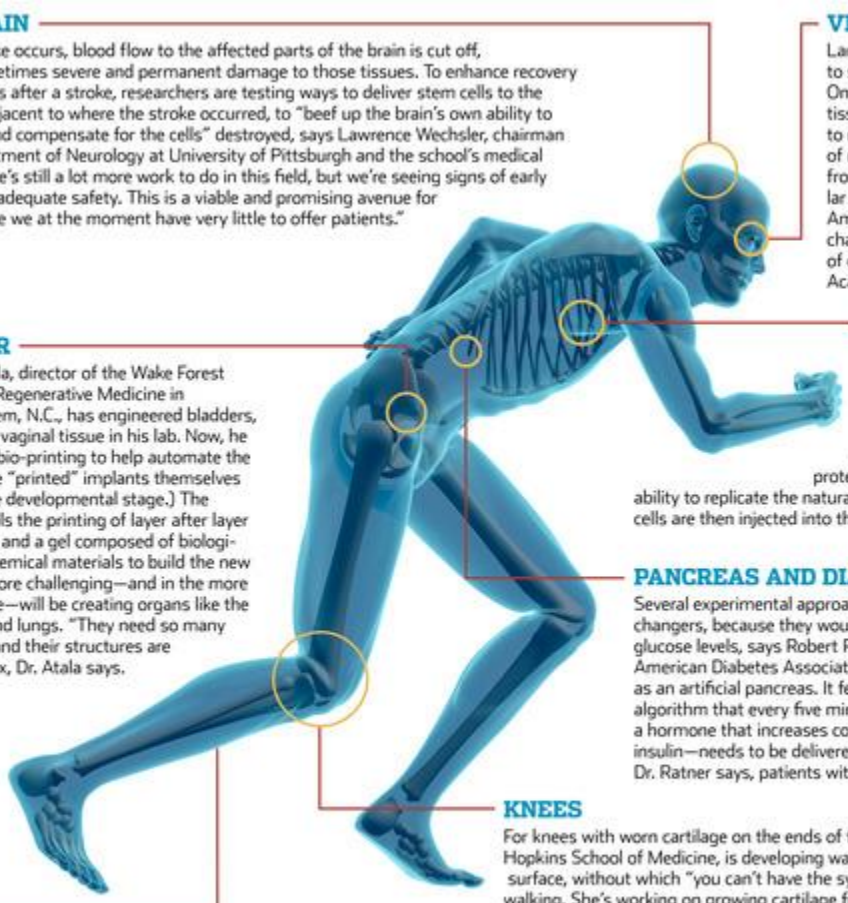
The idea of the body healing itself may be close to making a huge leap forward. Much closer than we think.

The rapidly evolving field of regenerative medicine—including stem cells, 3-D printing and bioengineering, among other technologies—is helping repair, and even regenerate, body parts and tissues damaged by disease, trauma or age.

“Regenerative medicine is not trying to create the bionic man but to harness the healing powers of the human body and buttress them,” says Andre Terzic, director of the Mayo Clinic’s Center for Regenerative Medicine in Rochester, Minn. That means treating chronic or degenerative ailments and replacing failing organs. In the U.S. alone, more than 120,000 people are on organ-transplant waiting lists.

Predictions, of course, are not always borne out. But “we’re making an awful lot of solid discoveries,” says Rosemarie Hunziker, director of tissue engineering and regenerative medicine at the National Institute of Biomedical Imaging and Bioengineering in Bethesda, Md.

Here’s a peek into what regenerative medicine’s human body shop may offer in the next decade.



THE BRAIN

When a stroke occurs, blood flow to the affected parts of the brain is cut off, causing sometimes severe and permanent damage to those tissues. To enhance recovery in the months after a stroke, researchers are testing ways to deliver stem cells to the brain area adjacent to where the stroke occurred, to “beef up the brain’s own ability to reorganize and compensate for the cells” destroyed, says Lawrence Wechsler, chairman of the Department of Neurology at University of Pittsburgh and the school’s medical center. “There’s still a lot more work to do in this field, but we’re seeing signs of early success and adequate safety. This is a viable and promising avenue for an area where we at the moment have very little to offer patients.”

VISION

Large strides are being made in stem-cell therapies to slow deterioration of vision or even restore sight. One method is to employ stem cells to grow new retinal tissue that can then be injected underneath the retina to replace dead or damaged tissue. “There are a number of retinal degeneration diseases that could benefit from this, but the most common is age-related macular degeneration,” which affects more than two million Americans age 50 and older, says Russell N. Van Gelder, chairman of the University of Washington department of ophthalmology and president of the American Academy of Ophthalmology.

BLADDER

Anthony Atala, director of the Wake Forest Institute for Regenerative Medicine in Winston-Salem, N.C., has engineered bladders, urethras and vaginal tissue in his lab. Now, he is using 3-D bio-printing to help automate the process. (The “printed” implants themselves are still in the developmental stage.) The process entails the printing of layer after layer of living cells and a gel composed of biological and biochemical materials to build the new body part. More challenging—and in the more distant future—will be creating organs like the heart, liver and lungs. “They need so many more cells,” and their structures are more complex, Dr. Atala says.

HEART

New tools are also in the works to help repair the damaged tissue and impaired function that occur after heart attacks. At the Mayo Clinic, stem cells are harvested from the patient’s bone marrow (lowering the risk of rejection) and are treated with what Dr. Terzic calls a “conditioning cocktail” of proteins and growth factors that endow them with the ability to replicate the natural cues of heart development. These bioengineered cells are then injected into the scarred or damaged area of the heart.

PANCREAS AND DIABETES

Several experimental approaches to diabetes treatment are “potential game-changers, because they would begin to mimic how Mother Nature” controls glucose levels, says Robert Ratner, chief scientific and medical officer of the American Diabetes Association. Dr. Ratner describes one biomechanical device as an artificial pancreas. It features a glucose sensor, a pump, and a computerized algorithm that every five minutes determines how much insulin or glucagon—a hormone that increases concentrations of glucose in the blood, the opposite of insulin—needs to be delivered. The device is currently in human trials. Potentially, Dr. Ratner says, patients with either Type 1 or Type 2 diabetes could benefit.

KNEES

For knees with worn cartilage on the ends of the bones, Jennifer Elisseeff, a professor at Johns Hopkins School of Medicine, is developing ways to rebuild cartilage and re-create its smooth surface, without which “you can’t have the synergy for lubrication” to lessen friction and pain when walking. She’s working on growing cartilage from the patient’s own stem cells for the particular repair needed (think of it as a hole to be filled) that could be implanted via arthroscopic surgery. And, Dr. Elisseeff says, “we’re creating a polymer material that is made up of synthetic and biological components” that would be injected to re-oil the cartilage surface. “This would actually rebuild the tissue” and bring back the lubricating function, she says. She is also working on similar repairs for meniscus cartilage, which cushions the bones and is prone to tearing and degeneration.

SKIN

If aging boomers decide they no longer like or want their tattoos, Dr. Atala foresees the possibility of replacing that patch of skin with a new piece of skin engineered from the person’s own cells and produced by 3-D printing.

ISTOCKPHOTO/GETTY IMAGES

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Corrections & Amplifications

The Wake Forest Institute for Regenerative Medicine is using 3-D bio-printing to automate the process of building human organs for eventual use in transplant surgery. An earlier version of the accompanying graphic stated incorrectly that printed organs have already been implanted in humans. (July 10, 2015)