# To restore vision, implant preps and seeds a damaged eye

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Researchers trying to restore vision damaged by disease have found promise in a tiny implant that sows seeds of new cells in the eye.

The diseases macular degeneration and retinitis pigmentosa lay waste to photoreceptors, the cells in the retina that turn light into electrical signals carried to the brain. The damage leaves millions of people worldwide with debilitating sight loss.

The nerves behind the light-switching cells, however, remain intact, meaning that with new photoreceptors, a patient could see again.

Early attempts to regenerate sight by injecting seed or progenitor cells that grow into photoreceptors into the eye of a mouse model failed.

"As with any part of the central nervous system, scar tissue is a barrier to regeneration," said Gary Wnek, a professor of macromolecular science and engineering at Case Western Reserve University.

Wnek, the Joseph F. Toot, Jr. Professor of Engineering, and Meghan Smith, a recent Ph.D. recipient at CWRU, joined a team of researchers from Harvard University and the University of California, Irvine, to design an implant that clears scar tissue left by disease and delivers progenitor cells.

They report their results in the January issue of *Biomaterials*.

Wnek and Smith made the micro-implant's scaffolding. They built a mesh through a process called electrospinning, which uses electrical charges to draw biodegradable polymers out of a needle and into a fine stream, producing interwoven fibers ranging from 1/20th to 1/1000th the width of a hair, Smith explained.

Embedded in the fibers are pockets containing enzymes which slowly migrate out as the polymer degrades, eating away local scar tissue and exposing fertile ground for the progenitor cells carried on the implant's surface.

Without the enzymes, the implant alone increased the number of progenitor cells reaching the degraded site 16-fold and survival 9- fold over injection in a mouse model. The mesh provided structural support for the cells and chemical support with a coating of extracellular fluid, said Budd A. Tucker, a postdoctoral fellow at the Schepens Eye Research Institute at Harvard and the lead author of the paper.

With the enzymes on board, the number of progenitor cells that implanted and survived increased another 15- to 20-fold Tucker said.

"No one knows what the magic number of cells needed to regain sight is," Tucker said. "But I suspect this is a reasonable number."

Published work has shown that people who suffer sight loss can regain visual acuity with the addition of fewer photoreceptor cells than the number that naturally populate a healthy eye, he said.

In a mouse model that received the implant, progenitor cells were taking on the form of mature photoreceptors and expressed mature photoreceptor markers 14 days after implantation.

Erin Lavik, a professor of biomedical engineering at Case Western Reserve, worked on early implant models with the Harvard researchers but is no longer involved in the effort. She's impressed by the new mesh. "It's an elegant system that can clearly modify the environment," Lavik said.

The scientists are already improving the system, making the mesh about one-quarter to one-sixth as thick and using a more flexible polymer that is, well, easier on the eye, said Stephen Redenti, an assistant professor of biological sciences at City University of New York, and an author of this current and an upcoming paper on the implants.

"The implant made with the new polymer is almost as small as we can go and still handle and deliver the implant surgically," Redenti said. The new material is more biocompatible, causing less irritation when implanted and no inflammation as the material degrades, he explained. "It can be tolerated by the body's physiology."

The researchers will shortly test the newest implant loaded with the scar-dissolving enzymes and progenitor cells to determine whether the system improves the function of a diseased eye.

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