Coatings to help medical implants connect with neurons

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Plastic coatings could someday help neural implants treat conditions as diverse as Parkinson's disease and macular degeneration.

The coatings encourage neurons in the body to grow and connect with the electrodes that provide treatment.

Jessica O. Winter, assistant professor of chemical and biomolecular engineering at Ohio State University described the research Thursday, August 21 at the American Chemical Society meeting in Philadelphia. She is also an assistant professor of biomedical engineering.

Worldwide, researchers are developing medical implants that stimulate neurons to treat conditions caused by neural damage. Most research focuses on preventing the body from rejecting the implant, but the Ohio State researchers are focusing instead on how to boost the implants' effectiveness.

"We're trying to get the nerve tissue to integrate with a device -- to grow into it to form a better connection," Winter said.

She and her colleagues are infusing water-soluble polymers with neurotrophins, proteins that help neurons grow and survive.

They are combining different polymers, some shaped like tiny spheres and fibers, to create composite coatings that release neurotrophins in a steady dose over time. The coatings also give nerves a scaffold to cling to as they grow around an implant.

The researchers coated two kinds of electrodes -- one, a flat electrode used in retinal implants, and the other a cylindrical electrode array used in deep brain stimulation. The first is being used in experimental treatments for macular degeneration, while the second holds promise for suppressing tremors in people who have Parkinson's disease.

The first coating they developed was made of polyethylene glycol-polylactic acid (PEGPLA) -- a polymer often used in medical implants.

They placed the PEGPLA-coated electrodes in an array of cell cultures and measured how long the coating dispensed the neurotrophins, and how the cells responded.

They tested the retinal implants with retinal cells taken from rabbits, and the deep brain electrodes with PC12 cells -- cells that grow into neurons -- which were taken from cancer tissue in rats. In both cases, neurons grew from the cells and extended toward the electrodes.

Ideally, Winter explained, coatings would release neurotrophins for up to three months, since that's the length of time that nerves in the body require to heal after implant surgery.

Using only PEGPLA, they found that the implant would release neurotrophins for three weeks.

That's why the researchers are now combining it with two other biodegradable polymers: polylactic co-glycol acid (PLGA) microspheres and polycaprolactone (PCL) polyester nanofibers.

In this scheme, one polymer releases an initial burst of the chemical, then another polymer begins its release, and then another.

At the time of the American Chemical Society meeting, Winter and her team were still measuring the performance of the PEGPLA-PLGA-PCL coating. But the initial results look promising.

"To get long-term release, we think these multi-component systems are the way to go," Winter said. "We can control the release by combining the materials in different ways, and we're confident that we can extend the release time further -- even to 90 days."

As researchers work to develop neural implants, they face many challenges, including how to provide enough electrical stimulation to nerves without damaging surrounding tissue.

Because the coatings encourage neurons to connect directly with electrodes, this technology could allow researchers to develop smaller implants -- ones that contain many densely packed electrodes to provide a high amount of stimulation in a small space, thus better preserving surrounding tissue.

Source: Ohio State University