

Engineers Discover Way to Link Plastic to Biological Materials

May 16 2005

Engineers at The University of Texas at Austin have found a way to modify a plastic to anchor molecules that promote nerve regeneration, blood vessel growth or other biological processes.

In the study led by Dr. Christine Schmidt, the researchers identified a piece of protein from among a billion candidates that could perform the unusual feat of attaching to polypyrrole, a synthetic polymer (plastic) that conducts electricity and has shown promise in biomedical applications. When the protein piece, or peptide, was linked to a smaller protein piece that human cells like to attach to, polypyrrole gained the ability to attach to cells grown in flasks in the laboratory.

“It will be very useful from a biomedical standpoint to be able to link factors to polypyrrole in the future that stimulate nerve growth or serve other functions,” said Schmidt, an associate professor of biomedical engineering at the university.

Schmidt is the principal author for the study conducted with colleague Dr. Angela Belcher at Massachusetts Institute of Technology. It was published online May 15 by the journal Nature Materials.

Polypyrrole is of interest for tissue engineering and other purposes because it is a non-toxic plastic that conducts electricity. As a result, it could be used to extend previous experiments in Schmidt’s laboratory. The experiments involve wrapping a tiny strip of plastic around damaged, cable-like extensions of nerve cells called neurites to help them regenerate.

“We can apply an electric field to this synthetic material and enhance neurite repair,” said Schmidt. The newly gained ability to attach proteins to polypyrrole, she said, will mean that growth-enhancing factors could also be linked to this plastic wrapping, further stimulating neurite regeneration.

Working with Schmidt and Belcher, the paper’s lead authors, graduate students Archit Sanghvi and Kiley Miller identified the peptide that attaches to polypyrrole from among the billion alternatives initially analyzed. These unique peptides were displayed on the outer surface of a harmless type of virus called a bacteriophage that was purchased commercially.

To hunt for the plastic-preferring peptide, Sanghvi and Miller added a solution containing bacteriophages that displayed different peptides to a container with polypyrrole stuck on its inner surface. The bacteriophages that didn’t wash away when exposed to conditions that hinder attachment were retested on a new polypyrrole-coated container, a process that was repeated four more times.

The sticky peptide selected, known as T59, is a string of 12 amino acids. To make certain that something else on the outer surface of the bacteriophage virus wasn’t responsible for its perceived stickiness, the researchers demonstrated that T59 by itself could attach to immobilized polypyrrole, using synthetic copies of it made at the university’s Institute for Cellular and Molecular Biology. In addition, they determined that a certain amino acid, aspartic acid, had to be a part of T59 for it to attach well to the plastic.

Aspartic acid carries a negative charge, which in T59 appeared to be drawn to the positively charged surface of the polypyrrole the way magnets of opposite charges cling together. Yet other peptides containing aspartic acid didn’t attach to polypyrrole, leading the

researchers to speculate that something contributed by the other amino acids in T59 influenced its 3-dimensional shape in a way that augmented its plastic preference.

“This aspartic acid is just one piece of the puzzle,” Sanghvi said. “There are still more pieces to put together.”

The researchers also evaluated how well T59 clings to polypyrrole. They attached copies of the peptide to the tip of an atomic force microscope at the university’s Center for Nano- and Molecular Science and Technology. The tip of this specialized microscope is normally passed across the surface of a material to “map” its peaks and valleys. In this case, the surface was a layer of polypyrrole, and the resistance of the peptide-coated tip to being passed across the surface revealed how well T59 clung to the plastic.

“They had a moderately strong interaction, which is useful to know,” Schmidt said, referring to the need for a stable attachment between polypyrrole and biological molecules that T59 would be used to link to.

Schmidt’s laboratory intends to study T59 as a linker to other molecules in the future, possibly including vascular endothelial growth factor, which stimulates the growth of new blood vessels. In addition, they will use the bacteriophage analysis approach, called high-throughput combinatorial screening, to look for peptide linkers for other plastics such as polyglycolic acid under study for tissue-repair or tissue-engineering purposes.

“This is a powerful technique that can be used for biomaterials modification,” Schmidt said, “and it hasn’t really been explored very much until now.”

Source: University of Texas at Austin

Citation: Engineers Discover Way to Link Plastic to Biological Materials (2005, May 16)

retrieved 25 April 2024 from

<https://phys.org/news/2005-05-link-plastic-biological-materials.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.