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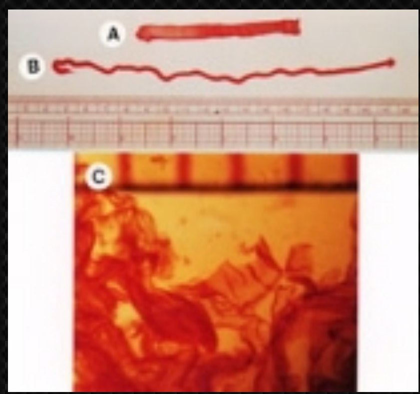

Fabrication of various geometric shapes of sapeptide scaffolds. (A) The tape is approximately 8cm long, 0.5cm wide and 0.3mm thick. (B) The rope is about 2mm in diameter. (C) Membrane form.

Image courtesy / Nature

New biomaterial is able to support living nerve cells

Deborah Halber, News Office
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Researchers at MIT and New York University reported in the June 6 issue of the Proceedings of the National Academy of Sciences that they have made a biomaterial that supports living nerve cells.

This peptide-based scaffold, on which neurons grow fibers to communicate with each other and establish functional synapses, may be the long-sought ideal medium for growing replacement nerve cells for victims of spinal cord injuries and other forms of nerve damage.

New biological materials based on the tiny protein linkages called peptides "will become increasingly important in developing approaches for a wide range of innovative medical technologies, including controlled drug release, new scaffolds for cell-based therapies, tissue engineering and biomineralization," predict authors Shuguang Zhang, associate director of the Center for Biomedical Engineering (CBE) at MIT; Todd C. Holmes (MIT PhD 1994), assistant professor of biology at NYU; and their colleagues.

This is the first peptide-based biomaterial of its kind that can be designed at the molecular level. Although parts of animal cells such as collagen can be extracted as a basis for growing cells, such animal-derived materials may carry and pass on viruses to the attached growing cells. In contrast, the new peptide-based material is not extracted from animal cells.

And unlike other synthetic materials, these peptides are completely biological. They are composed of amino acids, which are the building blocks of all proteins. The peptides do not evoke an immune response or inflammation in living animals, and they can be used for a variety of applications. "The reason this material is so interesting and unique is that we can individually tailor it to grow virtually every type of cell in the body," Dr. Zhang said.

"Further development of biological materials and related cell-based therapies may bring us closer to the elusive goal of repairing the damaged nervous system," wrote Melitta Schachner, a researcher in molecular neurobiology at the University of Hamburg in Germany. Her "News and Views" article about this work appeared in the journal Nature.

REGENERATING TISSUE

Researchers are working to develop new biologically compatible scaffolds for controlled drug release, tissue repair and tissue engineering.

Synthetic scaffolds have been used to grow skin, livers and cartilage, among other tissues, but some cells can't tolerate these scaffolds, which tend to be acidic.

While a successful scaffold has to be cell-friendly, it has to be particularly hospitable to grow nerve cells. The brain seems to keep firm control on the reproduction of its cells. Inhibitor molecules block regenerating neurons. Neurons grown on the wrong substrate die. After an initial period of development at the very beginning of life, very few new neurons are produced by the adult central nervous system.

The new biomaterial developed by Drs. Zhang, Holmes and colleagues seems to be an ideal substrate, or growing surface, for cells slated for replacing damaged tissue in the nervous system. Neurons attach to it and grow axons (the long tails through which they send signals). Active synapses – the spaces through which nerve cells communicate – form and survive in these cultured cells.

SMART LEGOS

Fragments of the 80,000-plus kinds of proteins in our bodies are called peptides. Peptides transform themselves like tiny smart Legos into millions of essential substances.

Dr. Zhang and other scientists have recently discovered that these same peptides can be tweaked into forming completely new natural materials that may be able to perform a variety of useful functions inside and outside the body.

Researchers have found that peptides can self-assemble into non-protein-like structures such as fibers, tubules, sheets and thin layers. They can be made responsive to changes in acidity, mechanical forces, temperature, pressure, electrical and magnetic fields and light. They are stable at temperatures up to 350ï¿½ï¿½ï¿½C and can be produced up to a ton at a time at affordable cost. They can be programmed to biodegrade.

Out of scientific curiosity, Dr. Zhang asked Dr. Holmes to test one of his self-assembling peptides for toxicity to nerve cells. Not only were they not toxic – they seemed to thrive in culture in the presence of a salt. With the salt, the peptides self-assembled into thin, wavy films that look a little like plastic wrap. Under a microscope, the film contained a network of fibers.

Further tests showed that nerve cells easily grew on these fibers. Although no immune response or inflammation was seen when the peptides were injected into rat muscle tissue, they have not yet been tested in the brain, spinal cord and peripheral nerves.

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of Santa Clara, CA; Guosong Liu of the Department of Brain and Cognitive Sciences at MIT; and Professor Alexander Rich, the William Thompson Sedgwick Professor Of Biophysics in the Department of Biology and the CBE at MIT.

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Topics: Biology Biotechnology