Delivering Drugs Faster

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People suffering from brain diseases and conditions ranging from traumatic brain injury to brain cancer to progressive brain disorders could be helped if therapeutic drugs could be easily delivered to the affected areas. The blood-brain barrier (BBB), composed of tightly interacting cells, acts as part of the body's defense system to block bacteria and other substances carried in the blood from invading the brain. It is extremely effective, which makes it very difficult to deliver important diagnostic and therapeutic agents to the brain.

Scott Banta is working toward solving this problem by using a biochemical engineering approach, creating specific cell penetrating peptides (SCPPs) that can cross the BBB and target specific brain cell populations. Banta and his research group are engineering new peptides that are specific for different cell and tissue types. The plasma membrane protects cells by regulating the access of molecules to the cellular cytoplasm. Only compounds within a narrow range of size, charge, and polarity are able to cross the membrane.

Using the process Directed Evolution, the Banta group is creating new SCPPs that are able to both target and penetrate specific cells. These peptide sequences can deliver therapeutic cargos, such as DNA, proteins, drugs, or other exogenous materials, to the targeted cellular cytoplasms.

Collaborating with Barclay Morrison of the Department of Biomedical Engineering, Banta is seeking to create SCPPs that are specific for different brain cell types. There is a narrow window of time following a brain injury where the targeted delivery of neurotrophic agents to injured cells could provide a significant benefit to the head-injured patient. In addition, delivery of neurotrophic factors via SCPPs could be beneficial in slowing down the progress of diseases such as Parkinson's, Alzheimer's, and Huntington's. This project has been supported by the National Institutes of Health and the National Science Foundation.

Banta's interests and expertise extend beyond the human body. In 2010, Banta was awarded an ARPA-E grant from the U.S. Department of Energy to launch new research on using genetic engineering to create renewable biofuels in collaboration with Alan West (Chemical Engineering) and Kartik Chandran (Earth and Environmental Engineering).

"We are going to use genetic engineering to incorporate a new metabolic pathway into an organism that is currently used for wastewater treatment," he said. "The bacterium, N. europaea, has the ability to grow on ammonia, oxygen and CO_2. We will engineer it to create isobutanol, which is a biofuel that is compatible with the existing transportation infrastructure. The cells will fix CO_2 from the atmosphere, and the ammonia will either be generated electrochemically, or it will be obtained during wastewater treatment."

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