Axon regeneration in response to nervous system injury

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Alexandra Byrne, PhD, assistant professor of neurobiology, is working to identify which genes control how the nervous system responds to injury. Specifically, the Byrne lab at UMMS is working to identify the genes that prevent injured axons from regenerating due to age or cell type.

"The ultimate goal of the lab is to not only understand how the nervous system responds to injury, but to develop future strategies for repairing the injured or diseased nervous system, for example a spinal cord injury or any sort of nervous system disease," Dr. Byrne said.

Byrne established her lab at UMMS in 2016. She worked as a postdoc at Yale University, where she identified and characterized previously unidentified regulators of axon regeneration in the young and aged nervous system, including poly ADP-ribosylation and insulin signaling. At UMMS, the Byrne lab studies the genetics of axon regeneration in C. elegans—a transparent roundworm about the size of a grain of sand with a conserved genome and a well-characterized nervous system.

In the lab, researchers use a laser to cut individual fluorescently labeled neurons in the worm. They then manipulate the genome to find out why axon regrowth is inhibited and use those findings to see how they can get injured axons to regrow.

"We've found a number of genes that are differentially regulated in two different types of axons," Byrne said. "We found that the ones that remove poly ADP-ribosylation encourage regeneration and the ones that add poly ADP-ribosylation inhibit regeneration. Now we're trying to figure out what's happening downstream; how is it that this pathway is regulating regeneration and which types of neurons is it acting in? Will this rescue regeneration in the older nervous system and what are the mechanisms by which it does that?"

Byrne said it's important to determine these factors in the worm to identify a specific target that can be manipulated to illicit regeneration in the mammalian system.

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