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A new pathway for neuron repair is discovered

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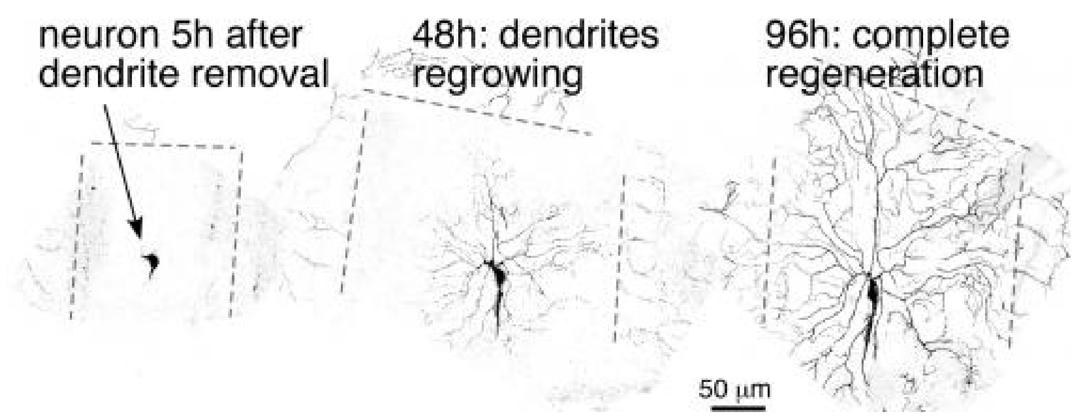

This image shows a single neuron in a whole animal 5 hours after dendrites were removed with laser surgery (left). The same cell was imaged at 48 hours and 96 hours after the dendrites were removed. At 48 hours (middle) a new dendrite arbor extends from the cell body, and by 96 hours the new arbor fills the entire space normally occupied by the cell. Credit: Melissa Rolls lab, Penn State University

Penn State University molecular biologists have discovered a brand-new pathway for repairing nerve cells that could have implications for faster and improved healing. The researchers describe their findings in a paper titled "Dendrite injury triggers DLK-independent regeneration," which will be published in the 30 January 2014 issue of the journal *Cell Reports*. These findings demonstrate that dendrites, the component of nerve cells that receive information from the brain, have the capacity to regrow after an injury.

Previous studies using many models have shown that when nerve cells, or neurons, are injured they repair the damage through regrowth of axons, the component of a neuron that sends information to other cells, explained co-author Melissa Rolls, associate professor of biochemistry and molecular biology at Penn State. "For example, if you break your arm and the bone slices some axons, you may lose feeling or movement in part of your hand. Over time you get this feeling back as the axon regenerates."

Using the fruit fly (*Drosophila*) as a model system, the researchers took what Rolls calls a "radical approach," cutting off all of the dendrites in neuron cells. "We wanted to really push the cells to the furthest limit," she said. "By cutting off all the dendrites, the cells would no longer be able to receive information, and we expected they might die. We were amazed to find that the cells don't die. Instead, they regrow the dendrites completely and much more quickly than they regrow axons. Within a few hours they'll start regrowing dendrites, and after a couple of days they have almost their entire arbor. It's very exciting—these cells are extremely robust."

Moreover, it appears that dendrite regeneration happens independently of axon regeneration. When Rolls and her colleagues blocked the key signaling molecules that are required for axon regeneration in all animals, they found that dendrites were unaffected and continued to regrow. "This means that, not only do these neurons have an incredible ability to generate, they have two different regeneration pathways: one for axons and one for dendrites," she said. "Because it has not even been clear that dendrites can regenerate, it's a complete open question about what might be involved in that process. The next step will be to look for markers for dendrite regrowth—proteins that are required or genes that are turned on in the process—so we can learn more about what's going on during dendrite repair. We don't even know in what scenarios dendrite regeneration might happen in people yet because no one has known that it exists."

The implications for human health—although a long way down the road—are important, Rolls said. For example, in the case of stroke, when a region of the brain suffers blood loss, dendrites on brain cells are damaged and can be repaired only if blood loss is very brief. Otherwise, it is thought those brain cells die. But if those cells are able to regenerate dendrites, and if scientists learn how dendrite regrowth happens, researchers may be able to promote this process.

"We've provided some cause for hope when it comes to neuron damage," Rolls said. "This is optimistic work we are doing. It's just great to know there is this whole other pathway for survival that no one has even looked into before."

Provided by Pennsylvania State University

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