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Nanosurgery operates at the cutting edge of medicine

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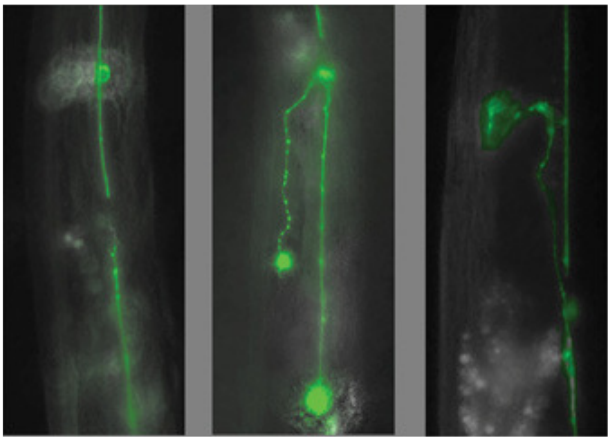
Nanosurgery is forever hitting the headlines as research groups around the world explore the myriad applications for this precise technique. Couple this to the development of lasers with ever shorter pulse durations, and it's little wonder that nanosurgery is creating quite a buzz in laboratories the world over.

Today, nanosurgery is employed mostly as an in vitro technique for cell and tissue manipulation and as an in vivo technique in model organisms. However, with future developments of hybrid technologies, such as pairing laser sources with imaging systems and developing safe and reliable biological methods for in vivo operation, nanosurgery is set to become a formidable method in medicine. Possible applications include gene therapy, nerve regeneration and cancer treatment involving the selective damage of tumoral cells.



High-throughput in vivo femtosecond laser surgery allowed discovery of drug leads that enhance neuronal regeneration. The first two panels show dramatic enhancement of axon regeneration when subjected to two potent chemicals with respect to a control (far right) without any chemical. Courtesy of Yanik Lab at MIT.

The first observations at the nanoscale were achieved nearly 80 years ago with the advent of electron microscopy in 1931. Manipulation at such a scale, however, had to wait another 25 years for the surgical removal of subcellular organelles (mitochondria) in the 1950s. The early 1960s saw the invention of the first lasers and, since then, optical manipulation at the nanoscale has become a key technology in many new fields of research.

Some of the main application areas include nanomechanics in surface physics, nanoelectronics in quantum computation, nanofabrication in materials science, molecular dynamics in biology, cellular and subcellular manipulation, and tissue engineering, among others.

A femtosecond laser severed the dendrite in this AFD neuron, which is the primary type of neuron underlying thermotactic behavior. Courtesy of Samuel Chung/ Mazur Group, Harvard University.

Precise nanosurgery ensures that nothing other than the targeted structure is damaged within the cell