A new wrinkle in mystery of light

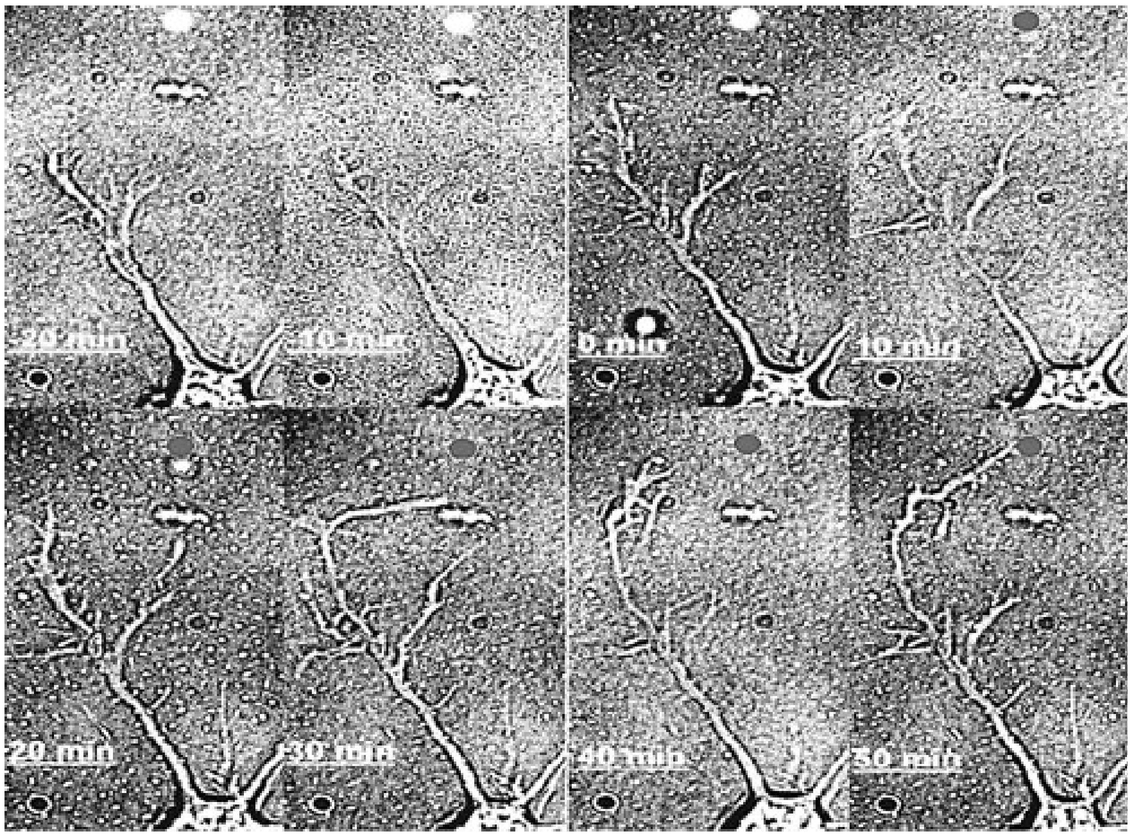
Barcelona scientists prove lasers can provoke nerve cell growth. The finding could lead to future treatments of nerve damage

JOSEPH WILSON

● A joint team of physicists and biologists based in Barcelona has recently made a discovery that one day could be used to treat cases of severe nerve damage. Nerve cells have been discovered to follow the pinpoint of a tiny laser beam just like a donkey can be lead with a carrot on a stick. While apparently simple, this finding has potentially groundbreaking applications.

Pablo Loza, experiment co-author and physicist from the Institute of Phonotic Sciences in Castelldefels, explains the experiment's potential: "Imagine any neural disease or a person with damaged nerve tissue, leukemia, Alzheimer's, Parkinson's, spinal cord injury... at the moment, none of these conditions have cures. They can be treated with therapy, but the nerve damage is permanent – the synapses [nerve connections] will never regenerate. So if we are able to provoke nerve cell growth in the direction we want, then it is possible we can provoke a neural reconnection."

Eduardo Soriano, from the Institute of Research in Biomedicine and Universitat de Barcelona and the group's leading neural biologist, agrees that "it is a promising technique," while urging caution when talking about possible future applications. He emphasises that the experiment is still "in its early phase" and any hypothetical applications are still just that – hypothetical.



Above, nerve cell growth can be seen starting at top left and finishing bottom right, the dot at the top is where the laser makes contact with the petri dish/ ICFO;left, Pablo Loza/LUIS MONTESDOCA; right, Eduardo Soriano/ RAIMON SOLÀ

Mouse brains

Loza and Soriano's experiment consists of two basic elements: a very powerful laser which pulsates at an incredible 80 million times per second, and nerve cells extracted from mouse brains. Instead of placing the laser directly on the nerve cell (which actually would kill it), they focus the miniscule beam near the cell's axon, or nerve ending. They found that after only five minutes the nerve cell started to grow in the direction of the laser. They then increased the experiment to three hours and found that the nerve cell would actually reach the position of the laser.

Loza gave this reporter the opportunity to watch some time-lapse footage of this odd phenomenon . The nerve cell's root-like axon normally grows by blindly feeling its way forward. Watching an axon tentatively groping for which direction to grow brings to mind the image of a blind man tapping to and fro in a short arc with his cane, left-right, left-right and then randomly inching in one direction, then the other. But when a laser is focused(as seen in the selection of photos above) nearby in the petri dish, it is as if the "blind" nerve suddenly has been granted "sight", and instead of randomly poking its tentacle-like philapodia from side to side, it begins to grow in a more or less straight line towards the laser.

The big question

Why? Why would a laser beam affect a nerve cell that never sees the light of day, given its location inside a skull? Loza and Soriano are not sure and this is what they are working on to find out.

At the moment they have three theories, one biological, one physical and one chemical.

> "Reconnecting broken synapses may be possible"

The first theory they are exploring is the possibility that there are proteins in the cerebral nerve cells which respond to light. These are known to exist in optical nerve cells, so perhaps they will be found in the cerebral cells as well.

The second possibility is that the laser is actually producing minute sound waves which attract the axons.

The final theory is that the laser is causing a chemical change in the cell's environment which favours its growth. Loza, while assuring that at the present moment all three ideas are equally valid, says he "would like the third theory to be true" since in his opinion it would be the most "promising when considering future applications."

In order to prove if any of these theories is correct, the team has just begun to test the technique on worms, since, as Loza puts it, "getting good results in the petri dish is very different from achieving the same results in a live specimen". Using a laser, they will cut the nerve which allows the worm to inch forward and then they will attempt to guide the regrowth of the worm's motor neuron. Since worms regenerate tissue naturally, the point is to compare growth rates between those treated with the laser technique to those left to their own devices.

After worms, the plan is to return to mice to see if damaged nerves synapses can be reconnected in live mammals. This is key, as Soriano explains, since "mammals, as opposed to reptiles, can not regenerate damaged nerve tissue".

Microscopic differences

● Loza and Soriano's experiment is not just noteworthy for its achievement and potential, it also a story of scientists crossing the borders of their own disciplines and the benefits, and stumblings, this can bring. While Soriano admits that both sides had moments of going back to basics of first year Biology or Physics in order to understand one another, he considers the experience "enriching, not only for the different techniques each side brings, but also for the dialogue generated by the different ways of thinking".

On a less philosophical note, Loza describes the somewhat awkward and humorous early steps of working with biologists. He tells the story of when the biologists first arrived in the physics lab. "They took a look at the microscope we had built from scratch, which was a just a lens with a camera, and asked 'Where's the microscope?'" Loza recounts with a laugh. They eventually bought a traditional microscope to make the biologists feel more at home. He also admits his own difficulties with the some standard vocabulary of biology. Even so, he believes "the future of scientific research lies in interdisciplinary research."