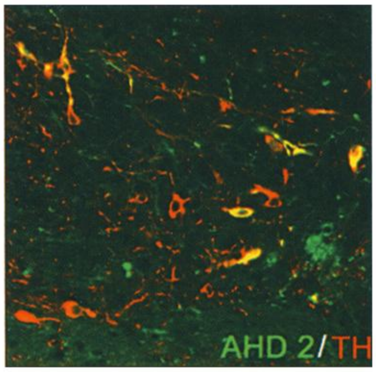
son's patients. "This shows that it can be done, but there are big obstacles to bring this to clinical fruition," says Ole Isacson of Harvard Medical School in Boston, who led the group. Among the caveats: Several rats developed deadly tumors, and the animals' behavioral improvements were limited.



Pot of gold? Mouse embryonic stem cells injected into rat brains express the AHD2 protein marker (yellow) characteristic of cells lost in Parkinson's disease.

Isacson's approach was surprisingly straightforward: He and his colleagues simply injected untreated ES cells into the rats' brains. In previous experiments, Isacson, postdoc Lars Björklund, and their colleagues had found that undifferentiated ES cells, when injected into animals, seemed eager to become neurons. However, the cells frequently grew out of control and formed teratomas, tumorous growths comprising a mix of cell types. Isacson and Björklund suspected that the differentiating ES cells were sending conflicting signals to each other that promoted the growth and formation of the teratomas. The team decided to test whether diluting the cells would lessen the chance that the cells would interact with each other, thereby encouraging development along the possible default pathway: making neurons. The team prepared mouse ES cells in a dilute solution and injected about 2000 cells each into the brains of 25 rats. The rats had previously had their dopamine-producing neurons damaged and showed a characteristic tendency to move in circles toward the damaged side of the brain.

Six of the rats showed no evidence that the transplanted cells survived. Five died before behavioral tests were completed and proved to have teratoma-like tumors. But 14 of the rats had surviving mouse cells in their brains 4 months after surgery. All of the surviving grafts contained at least some dopamine-producing neurons. And many of those neurons expressed a protein marker called AHD2, a marker typical of the specific kinds of neurons lost in Parkinson's disease.

"What this work shows is that you can easily get dopamine-producing neurons in the brain," even from undifferentiated ES cells, says developmental neurobiologist Ron McKay of the National Institute of Neurological Disorders and Stroke in Bethesda, Maryland.

And the new neurons seem to have reduced Parkinson-like symptoms in the animals. The scientists observed a gradual decrease in the abnormal rotations; by 9 weeks following the surgery, the 14 rats with surviving ES cells had improved by an average of 40% over their pretransplant state. Rats that received sham surgeries showed no improvements. But Anders Björklund of the University of Lund in Sweden cautions that the functional effect is very small. He notes that other transplantation experiments using dopamine-producing neurons from fetal brain tissue (a technique now being tested in humans) regularly produce much more dramatic results.

To Lorenz Studer of the Memorial Sloan-Kettering Cancer Center in New York City, "the results suggest that the fewer cells you put in, the bigger the influence of the environment becomes. If you dilute them sufficiently, you can get them to disregard this tendency to cause tumors."

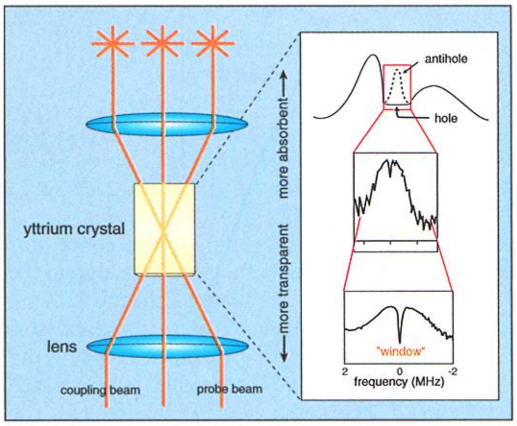
Studer adds that the relative ease with which dopamine-producing cells developed from the injected ES cells suggests that there might be a way to prompt rare stem cells already in the brain to become dopamine-producing neurons, allowing doctors to avoid the issue of transplanting cells altogether.

—GRETCHEN VOGEL

OPTICS

Crystal Stops Light in Its Tracks

Baby-boomer superheroes, take heart: Despite your aging knees, you can still run faster than light. For years, physicists have been slowing light down to a crawl, and even stopping it in its tracks, by shooting laser beams into cold gases known as Bose-Einstein condensates (BECs). Now, researchers have done the same thing in a much less exotic solid. The advance may one day lead to memory devices for computers that store information on beams of light.



Squeeze play. Shrinking the range of frequencies a crystal can transmit slows light to a crawl.

The work builds on experiments Lene Hau of Harvard University performed in the late 1990s. Hau and colleagues managed to slow light down to a poky 17 meters a second—below the top speed of a bicycle. The group used lasers to poke a spectral "hole" in a BEC of sodium atoms, making it impossible for the condensate's electrons to absorb light of a certain color. Two lasers, known as the probe beam and the coupling beam, zapped the atoms in the condensate, causing their electrons to interfere with each other in ways that made it impossible for them to absorb photons of a certain frequency. As a result, the BEC became transparent to light within a narrow range of frequencies of yellow-orange light. The speed of light in a medium is related to how readily the medium absorbs light of different frequencies; sharp variations in absorption across a narrow range of frequencies dramatically slow a pulse of light. Thus, the tiny spectral hole caused an unprecedented slowing.

Unfortunately, BECs exist only within a few hundred nanokelvin of absolute zero. Solids can exist at warmer temperatures. But in solids, unlike BECs, the laser-induced transparency trick makes too wide a spectral hole to slow light appreciably, says physicist Phil Hemmer, now at Texas A&M University. To narrow the hole, Hemmer and colleagues used two beams from a dye laser to create a large spectral hole in an yttrium crystal. A third beam increased the absorption inside the hole to create a smaller "antihole." Happily, the coupling and probe lasers also bleach a narrow anti-antihole of transparency inside the antihole, yielding a range of transparency narrow enough to slow down light to 45 meters per second.

Furthermore, when they shut down the coupling field, the crystal brought the beam to a halt by absorbing and storing the light, and eventually released it when the coupling laser was turned back on—a trick Hau also had performed earlier with BECs (*Science*, 26 January 2001, p. 566). "You preserve phase and amplitude," says team member Alexey Turukhin, a physicist at the Eatontown, New Jersey, branch of laser company JDS Uniphase. As a result, Turukhin says, the light can store information in ways that make it suitable for quantum computing. And although the yttrium crystal must be kept at a chilly 5 kelvin, it is still much easier to handle than a BEC, an important consideration for commercial devices that store light pulses. What's more, Hau notes, light pulses shrink as they slow down, a property that might give scientists an efficient means of compressing information stored on light pulses.

—CHARLES SEIFE