SCIENCE NEWS of the week

Tracing Earliest Neurons' Migration

In a vertebrate embryo, the brain develops when neurons are generated along the lining of the brain's innermost cavities, the ventricles, and migrate to the outer rim of the brain. There they settle, gradually building up the many layers of the mature brain.

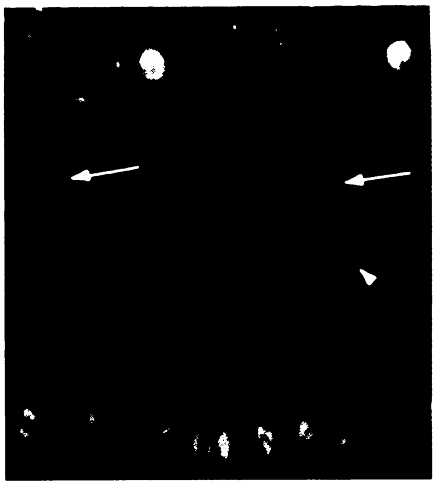
Scientists know little about the earliest stages of this process. Lacking a way to identify very young neurons, researchers could not tell them from nonneuronal brain cells, known as glia.

Now, researchers at Case Western Reserve University in Cleveland have found an antibody that labels these earliest neurons in rat embryos. By attaching a fluorescent tag to the antibody, the scientists can light up immature neurons as they arise in the ventricles and move away from their birthplace.

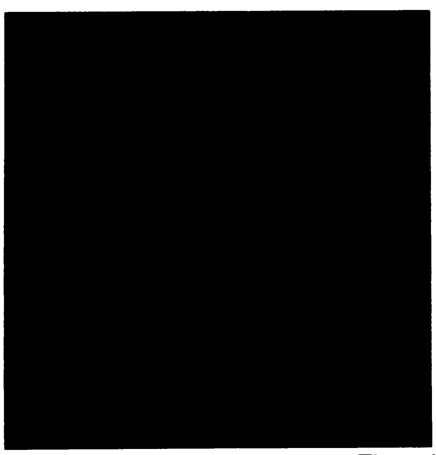
"We think that this antibody labels an unknown and newly discovered population [of neurons] that is very widespread throughout the central nervous system," says Jerry Silver, a Case Western neuroscientist. These cells occur in the retina, the spinal cord, and the brain's cortex, Silver's team reported at the annual meeting of the Society for Neuroscience, held this week in Washington, D.C.

The immature neurons first appear around the 11th day after gestation, when the embryo is about the size of a grain of rice, explains Silver. Previously, researchers could not visualize neurons until a day later, when many were well on their way to their destinations.

Earlier studies had discovered that neurons leave the ventricles by crawling along slender cells, called radial glia, that span the brain from center to surface, like the spokes of a wheel. Other studies showed that some neurons cross the brain obliquely rather than heading straight for the outer regions.



Earliest phase of neuronal migration in the cortex, 15 days after gestation. Emerging neurons (green, at bottom) extend thin arms upward (arrows). A slightly older neuron is ascending along its arm (arrowhead); three neurons have already arrived in the upper cortical zone (red).



Photos: Brittis/Silver

Rat retina 13 days after gestation. The red cells, scattered throughout, are neuronal precursors – immature cells that until now could not be visualized as neurons this early in development. The green cells are more advanced neurons.

However, Perry A. Brittis, Silver's coworker, observed that the youngest neurons do neither. Instead, each cell sends out a thin process to the brain's rim and transfers its nucleus and cellular material along that thread, much as a yo-yo moves up on its string. As the cells move, they lose these trailing processes. First described in 1970, this kind of cell migration had almost been forgotten, Silver notes.

"At that very early stage, it seems to us, this 'yo-yoing' is the easiest way for the neurons to reach the brain's surface," holds Brittis. "Days later, as the brain becomes more complex, they wander along the radial glia or in oblique directions, as was demonstrated earlier. Our antibody also captures that."

"It's a neat study," comments Dennis D. M. O'Leary, a neuroscientist at the Salk Institute for Biological Studies in La Jolla, Calif. "It shows very convincingly something that several researchers have suspected for a long time."

As cells leave the ventricles, new ones take their place, says Silver, continually replenishing the supply of immature neurons to populate the developing brain.

– G. Strobel

How to get order out of stirring things up

It's not unusual to mix up a batch of batter and still find unpalatable lumps of dry flour or baking powder embedded in the finished pancakes. Similar problems sometimes bedevil the mixing of ingredients, whether solid or liquid, in the chemical and pharmaceutical industries.

Now, researchers suggest that a simple mechanism may underlie many of the situations in which coherent structures – lumps – persist in the midst of the turbulent flows that surround them.

"Our work implies that coherent structures are in fact generic in any flow generated by stretching and folding," says Troy Shinbrot of the chemical engineering department at Northwestern University in Evanston, Ill. "Moreover, the work tells us exactly how to perturb a given system to create, manipulate, or destroy these structures."

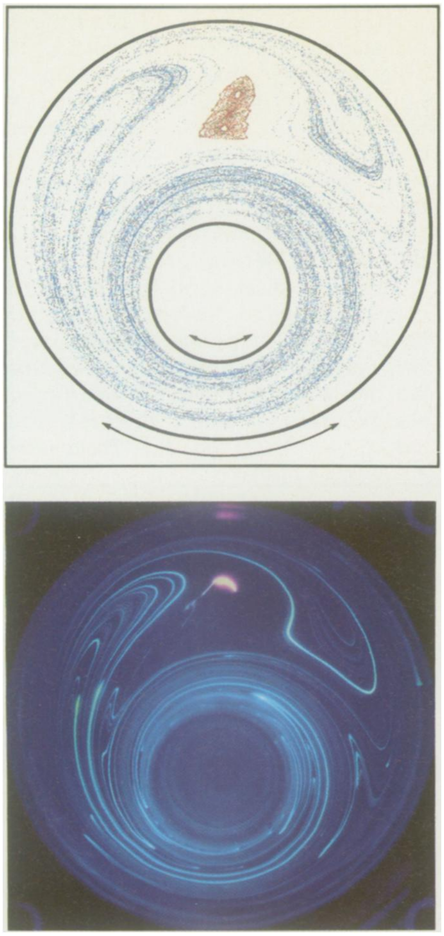
The notion that mixing can be regarded as the stretching and folding of a material originated with British physicist Osborne Reynolds, who first described this process in 1894. The idea was revived in the 1980s by Northwestern's Julio M. Ottino, who used stretching and folding to model how disorder can emerge out of a simple mixing process.

As any mixture is stirred, the material is first stretched out – elongating like a wad of taffy – then folded over into a horseshoe shape. With each successive stretch and fold, any two particles along the horseshoe's legs get farther apart, eventually ending up separated by some random distance.

Shinbrot, working with Ottino, wondered whether the same stretching and folding process can also preserve coherent structures. He noticed that particles very close to a fold move only a short distance apart. Thus, after an initial stretch and fold, the movement of these particles can be minimized by getting the second fold to occur at roughly the same point as the first. By keeping successive folds near a specific point in a mixture or a stirred fluid, the material near the fold remains intact.

To demonstrate the effect, Shinbrot and Ottino turned to an apparatus consisting of two cylinders, one inside the other but placed off center. By pouring a thick liquid into the space between the cylinders, then slowly rotating the inner and then the outer cylinder back and forth, the researchers could induce flows in the liquid that produce patterns characteristic of stretching and folding.

Typically, a sequence of rotations would rapidly distribute a drop of dye injected into the body of the liquid throughout the material. But by adjusting the sequence of rotations to keep the



Shinbrot

Viewed under ultraviolet light, glycerine glows with a blue color (bottom). A drop of dye injected into the body of the liquid spreads out into an intricate maze of pale blue threads. A differently colored dye injected into one particular region of the liquid stays in roughly the same spot (seen as a small, bright region near the top of the photo). The resulting patterns of fluid motion resemble those seen in computer simulations predicting the occurrence of this type of flow (top).

folds within a certain region, a drop of dye injected into that region would essentially stay put (see diagram and photo).

By modifying the rotation sequences, the two researchers can independently control the location of a coherent structure and any movements that occur inside it. Conversely, they can also specify the type of stirring needed to guard against incomplete mixing.

These results, which apply to flows within a closed system, represent only a first step toward understanding structures – like the Great Red Spot, Jupiter's remarkably stable whirlpool – that arise in turbulent flows. The researchers are considering ways of extending their work to more complex situations such as wakes produced by fluid moving past an object.

Shinbrot will describe his findings later this month in Albuquerque, N.M., at a meeting of the American Physical Society's fluid dynamics division.

– *I. Peterson.*

Digging up cleaner-burning cooking fuels

More than half the world cooks and heats with biomass fuels – usually wood, dung, or crop wastes. Often inexpensive and readily available, such fuels emit smoke and other noxious pollutants when they burn. Indeed, these fuels probably foster much of the respiratory disease seen in rural women and children in developing countries, the World Health Organization reported last year.

"We're all trained to think of wood as the premier biomass fuel," says Eugene B. Shultz Jr. of Washington University in St. Louis. But his data indicate that for arid climes, a healthier gold standard might lie underfoot: the roots of wild melons and gourds.

Shultz happened onto the idea of root fuels while looking for plant sources of alcohol that people could grow in dry lands without irrigation. Among the most promising was buffalo gourd, *Calabacilla loca.*

Driving past a research plot of the viny plants one day, Shultz spied what he took to be a pile of kindling. Having a fireplace, he stopped to pick some up. What he found were actually discarded *C. loca* taproots that had dried to wood-like hardness in the New Mexico sun. He took some home anyway, and when he saw how well they burned in his fireplace, "the wheels started turning," the combustion scientist recalls.

That was eight years ago. Since then, he and anthropologist Wayne G. Bragg, of Enable International in Wheaton, Ill., have enlisted scientists on several continents to scout local flora for regional surrogates. The star performer is *Cucumis hirsutus.* Zimbabwe-based botanist Mary Wilkins/Ellert collected samples of this wild plant, indigenous throughout much of southern Africa.

In May, she, Shultz, and a development researcher from Lutheran World Service recruited village women in Zimbabwe to compare *C. hirsutus* and another root against a local wood. Working over a simple fireplace in the middle of a poorly ventilated, thatched dwelling, the women prepared a batch of sadza – a thick cornmeal mush that serves as a dietary staple – using each fuel. *C. hirsutus* not only ignited most readily, but also produced almost no smoke.

During the tests and at a later debriefing, a translator recorded comments by the cooks – and onlooking village skeptics. The women judged the roots superior to the local wood and asked for seeds to begin cultivating *C. hirsutus,* Shultz reported last month in Fort Collins, Colo., at the International Conference on Sustainable Village-Based Development.

In August, Shultz's team conducted root-fuel tests at four rural sites in central and northern Mexico. Here, women prepared a full meal, including tortillas, over stoves fueled with *Cucurbita foetidissima.* As in Zimbabwe, Shultz says, all preferred the easy-to-ignite roots and their relatively smokeless fires.

Though roots tend to burn more slowly than wood – requiring a lowering of the pots on most stoves – cooks found they needed only two-thirds as much root as wood to cook a meal. And cultivation trials with buffalo gourd in Arizona indicate that a three-month crop delivers almost twice the yield of mesquite grown for one year on dryland sites – 11 metric tons per hectare for the root versus 6 metric tons for mesquite.

"If it's in the ballpark of being twice as productive as mesquite, [root fuel] may be a good choice of biomass crops," says Jonathan Scurlock, a biomass-energy expert at King's College in London, England. Moreover, he applauds the fact that Shultz involved social scientists and extension agents in his research. Their absence, he notes, has doomed the success of many technology transfer projects in developing countries.

Shultz/Washington Univ.

Top: Claudia, one of Shultz's "research associates," cooks tortillas over root-fired stone-and-sheet-metal stove. Below: Sun-dried buffalo-gourd roots.

Shultz's team "is in the forefront with a totally new idea," says Noel Vietmeyer of the National Academy of Sciences in Washington, D.C. "Only time will tell as to how [root fuels] catch on."

But "costing virtually nothing" and offering potentially important health benefits, the fuels "could change the lives of some very desperate people – the poorest of the poor" – Vietmeyer maintains.

– *J. Raloff*