

# Research Roundup

## A loss, or two gains?

Complex nervous system patterning—usually assumed to have coevolved with advanced, centralized nervous systems—may have arisen before nerves consolidated into a central nerve chord, according to Christopher Lowe, John Gerhart (University of California, Berkeley, CA), Marc Kirschner (Harvard Medical School, Boston, MA), and colleagues.

Their idea runs counter to the prevailing theory of dorsoventral axis inversion. The ventral nerve chords in arthropods (such as *Drosophila*) and dorsal nerve chords in chordates (such as humans) have been thought to be related via an inversion event some time during evolution. In the new theory, however, the original ancestor is proposed to have had a dispersed nervous system that converged centrally in independent dorsal and ventral events.

Reconstructing chordate evolution is tricky for several reasons. The rapidity of the Cambrian explosion and the soft bodies of the ancestors of chordates make it impossible to construct precise evolutionary trees. And chordates' closest major relatives, the echinoderms, have added so many bizarre anatomical features that they are next to useless for comparisons. Thus, the new study subject is the acorn worm. These hemichordates are a lesser-known lineage but, like the chordates, they are bilateral deuterostomes, in contrast to arthropods, which are protostomes and thus more distantly related.

The basic result of the new paper is simple. Although acorn worms have distributed nerve nets rather than nerve chords, they

express 22 genes in sets of anterior, midlevel, and posterior domains, whose relative positions are conserved with the patterns found in chordates. The authors argue that the ancestor of deuterostomes (and probably protostomes, as well) had a similar combination of a patterned but noncentralized nervous system.

If nerve chords formed twice during evolution, they might be expected to have formed in two different ways. The evidence here is split: the chords from arthropods and chordates are started off by two similar inducing molecules but finished off by very



Lowe/Elsevier

Acorn worms have a dispersed but patterned nervous system.

different molecules.

Lowe acknowledges that during evolution acorn worms may have lost a central nervous system rather than having failed to gain it. He expects that more examples like the acorn worm in other branches of the evolutionary tree will help support the new model. But, he warns, “this is going to continue to be a really difficult problem to resolve.” ■

Reference: Lowe, C.J., et al. 2003. *Cell*. 113:853–865.

## Nervous picket fences

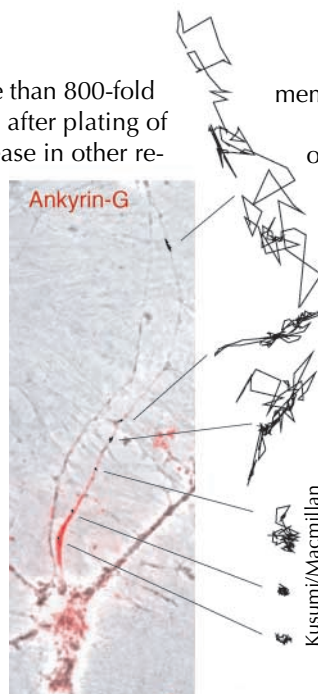
A neuron is a dual-function device—it does both input and output—but it has only one continuous plasma membrane. Protein transport helps to define the two different compartments, but without a barrier membrane, proteins will eventually intermix. Now, Chieko Nakada, Akihiro Kusumi (ERATO and Nagoya University, Nagoya, Japan), and colleagues confirm that neurons do have a membrane diffusion barrier, and they propose a mechanism by which it is constructed.

A diffusion barrier at the axonal initial segment (IS; the axonal area nearest the cell body) has been proposed before. But there have always been caveats: the introduced dye might have had too far to travel, or the latex bead used during testing might have cross-linked and thus immobilized its target.

The Japanese team used three single-molecule techniques to demonstrate that diffusion of a phospholipid in the IS

area decreased more than 800-fold between 6 and 10 d after plating of a neuron. The decrease in other regions of the neuron was only one- to threefold.

The diffusion barrier arose coincident with the concentration of actin, ankyrin, and various transmembrane proteins in the IS area, and partial disruption of actin made the lipid mobile once again. This reminded Kusumi of his earlier results in non-neuronal cells, in which lipids appeared to “hop” between actin-dependent plasma



Axonal lipids near the cell body (bottom) are slowed by picket fences.

membrane compartments.

The team thus adopted a version of this model in which actin cables provide the scaffolding, and “transmembrane proteins act like pickets for the fence,” says Kusumi. But could such a scheme explain not just slowed diffusion but a definitive barrier? The team modeled the behavior of membrane proteins and lipids and found that, sure enough, the diffusion rate decreased by a factor of 500 when the boundary coverage by the transmembrane “pickets” increased from 5% to just 25%. Thus, says Kusumi, “you don’t have to close off the boundary completely. Lipids next to immobile proteins become harder to move . . . so the barrier function propagates.” ■

Reference: Nakada, C., et al. 2003. *Nat. Cell Biol.* 5:626–632.