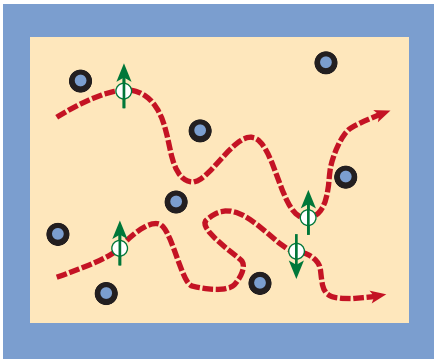

Figure 1 **Electrons diffusing through a disordered metal have more opportunity to interact. These interactions can be different for spin-up and spin-down electrons in a ferromagnet. According to Manyala *et al.*[1] these interactions provide a new mechanism for magnetoresistance, the effect used to store information on a computer's hard disk.**

netoresistive devices. These include artificially engineered nanostructures in which interfacial spins modulate the electron transport, producing 'giant' magnetoresistance[6], as well as manganite perovskites with metal–insulator transitions driven by magnetic fields, commonly referred to as 'colossal' magnetoresistance[7].

The magnetoresistance of $Fe_{1-y}Co_ySi$ is relatively modest, but it results from a new microscopic mechanism that could lead to the development of different magnetic materials. Moreover, it suggests that there is a universal behaviour underlying the properties of an entire class of complex materials. Here, the parent compound, FeSi, is basically an insulator with peculiar electrical, magnetic and optical properties. But when it is doped, it behaves just like a simple doped semiconductor with enhanced interactions between electrons[8]. Thinking about FeSi in these terms helps to explain why a compound that is 50% iron is not a magnet, whereas adding a non-magnetic dopant such as cobalt creates a metallic ferromagnet. A host of tailored materials, and no doubt some scientific surprises, should be possible through a combination of physical insight and the richness of the periodic table. ■

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Neurobiology

Dendrites go up, axons go down

Stephen M. Strittmatter

Dendrites and axons, collectively known as neurites, project from the cell bodies of neurons and are specialized for the receipt and transmission of nerve impulses. During development, both types of neurite must grow with the right spatial orientation to make the correct connections.

On page 567 of this issue[1], a group in the laboratory of Anirvan Ghosh (Polleux *et al.*) describes how a guidance factor called semaphorin 3A (Sema3A) acts as a chemoattractant for dendrites growing from certain neurons. The same molecule acts as a chemorepellant for axons growing from these neurons. One notable aspect of the work is that it brings a unifying element to research on axonal and dendritic guidance; another is that it highlights the role of cyclic nucleotides in creating nervous system patterning.

Numerous axon guidance factors have been identified and classified as attractive or repulsive (or sometimes both)[2]. Among them are the semaphorins, a large family of secreted and membrane-associated factors, one of which (Sema3A) repulses primary sensory axons in the peripheral nervous system during early development[3].

Ghosh's group is exploring the function of Sema3A in the development of cerebral cortex. They work on pyramidal neurons, which carry information from the cerebral cortex to various target areas elsewhere in the brain and spinal cord. In earlier research[4], they labelled cortical neurons, plated them on slices of cortex, and found that this slice-overlay technique faithfully recapitulated the growth trajectories of pyramidal cell axons *in vivo*. Other evidence[4] — from co-culture experiments, antibody perturbation studies and analyses of mice in which the gene encoding Sema3A had been knocked out — implicated Sema3A and its receptor subunit neuropilin-1 (NP-1) in directing axon projections. The data suggested that there is a gradient of Sema3A in the developing cortex; its concentration is high in one region (near the pial surface) and low in another (the subcortical white matter). The implication was that axons are repelled by Sema3A and grow down the gradient towards the subcortical zone.

Polleux *et al.*[1] have now extended the analysis of cortical slice overlays to look at dendrite orientation. Pyramidal cell dendrites grow from the apical side of the cell body, opposite the axons. They develop after axons, and extend in the opposite direction, towards the pial surface. Remarkably, it turns out that Sema3A and NP-1 are also required for dendritic patterning. An altered Sema3A gradient can redirect apical dendrites, and dendrite orientation does not depend on previously established axonal orientation. These results were confirmed by an analysis of mouse cortex lacking Sema3A. Thus, the apical dendrite of cortical pyramidal cells extends up the Sema3A gradient towards the pial surface even though the axon of the same cell is repulsed by Sema3A (Fig. 1).

The Sema3A gradient seems not only to direct apical dendrite extension but also to determine the site at which the dendrite forms on the cell body. Similarly, studies of semaphorin action in the grasshopper limb bud show that semaphorins contribute to the place of neurite initiation as well as directing the growth of established neurites[5].

Although other semaphorins have been reported to attract certain neurites[6,7], this is the first example of Sema3A doing so. More significantly, it is the first instance of two neurites from the same cell responding in opposite fashion to the same guidance signal. A concentration gradient formed by one

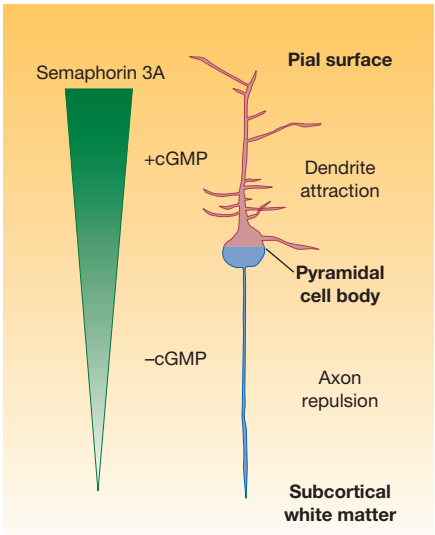

Figure 1 **Development of axonal and dendritic architecture in the cerebral cortex. Pyramidal cells in the cerebral cortex project a dendrite from the apical surface of the cell body towards the pial surface; an axon grows in the opposite direction, towards the subcortical white matter. Polleux *et al.*[1] show that a gradient of semaphorin 3A (Sema3A) in the developing cortex is responsible for the orientation of both the dendrite and the axon. An asymmetric concentration of soluble guanylyl cyclase, which creates the signalling molecule cGMP, might underlie dendrite attraction to Sema3A.**

factor is sufficient to generate opposing axonal and dendritic projections.

What signal transduction mechanisms might be involved in producing these different responses mediated by NP-1? Receptors for semaphorin include the plexins as well as neuropilins[8,9]. Plexin distribution in cortical neurons is unknown, but it is conceivable that different plexins associate with NP-1 in axons and in dendrites to produce the opposite guidance response. However, the work of Polleux *et al.* suggests another cause — that the signalling molecule cyclic guanosine monophosphate (cGMP) is a primary determinant of the different responses to Sema3A. This possibility was evident from work on isolated *Xenopus* spinal neurons, in which axon responses to Sema3A can be converted from repulsion to attraction by raising levels of cGMP[10].

For cortical pyramidal cells, Polleux *et al.*[1] report that soluble guanylyl cyclase is distributed asymmetrically; this is the enzyme responsible for producing cGMP. The asymmetric distribution is first evident as a cap of guanylyl cyclase on the cell body, which precedes the emergence of the apical dendrite itself. How this cap is produced is not known. Nevertheless the high levels of enzyme in apical dendrites imply that local concentrations of cGMP might contribute to attraction. Indeed, reagents that reduce cGMP levels or activity disrupt the dendritic response to Sema3A. The axonal response seems to occur in cellular regions of low cGMP concentration and is unaffected by these reagents. So these studies illuminate one of the first physiological settings in which cyclic nucleotides modulate neurite guidance[11].

What next? We need to find out whether other signalling components exhibit differential subcellular localization within various neurons and contribute to selective responses. In addition, other semaphorins (3B and 3C) are expressed in the developing cortex and modify cortical axon outgrowth *in vitro*[6]. It seems that Sema3A is a major determinant of both dendritic and axonal trajectories, but the relative contributions of Sema3B and 3C to the creation of cortical architecture require investigation. ■

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Ornithology

British birds by number

Robert M. May

So far, about 1.5 million different species of plants and animals — or, more strictly, eukaryotes — have been named and recorded. No one really knows how many different eukaryote species may be alive on Earth today; defensible estimates range from 3 million to 100 million or more.

But we know a lot about birds. They tend to be around during the day, fairly conspicuous, and often pretty or doing interesting things (or both). Globally, the recorded total of living species, close to 10,000, is almost surely within a couple of per cent of the true total. And we know a lot about British birds in particular. Britain is a small, densely populated country, with a long tradition of public enthusiasm for natural history (especially from energetic clergymen). One contemporary measure of British affection for things avian is that the Royal Society for the Protection of Birds (RSPB) has around one million members, whereas hedgehogs (top of the non-domesticated mammals) only attract around 10,000 friends. There are no societies to express public goodwill towards nematodes.

So it is not surprising that when in May 1999 Britain's Department of Environment, Transport and the Regions (DETR) issued its policy document, *A Better Quality Of Life*, among its 14 'headline indicators' was one for wildlife based on population trends of common breeding birds. In the latest development, the RSPB and the British Trust for Ornithology (BTO) have just published *The State of the UK's Birds 1999**, the first in an annual series of reports surveying the fates of Britain's bird populations.

The wild-bird headline indicator summarizes the trends in abundance of 139 species over the past 30 years. The observed breeding population of each species is arbitrarily scaled to 100 in 1970, the starting year, and subsequent changes are measured against this; the overall 'common bird index' is a simple average of the 139 species. This index rose to just over 110 in the mid-1970s, as many populations recovered from the severe winters of the early 1960s. It has subsequently fallen about 7% from the mid-1970s to 1998, but is still just over 100.

This figure may look encouraging, but less happy trends lurk within it. Woodland birds (41 of the 139 species) are down 20% from the mid-1970s. Farmland birds (20 species) are down 40%, with intensification of agriculture being widely accepted as the explanation.

In a post-Rio Biodiversity Action Plan, British government agencies identified 25 species of breeding birds that are either globally threatened with extinction or whose populations have halved or worse over the past 25 years, or both. For each such species DETR has published an action plan, with specific targets that require a halt in downward trends, and in most cases a return above mid-1990 levels by 2008. These 25 are subdivided into ten species that are widespread in Britain, and 15 that are scarce or rare.

Of the widespread ten, six (turtle dove, grey partridge, spotted flycatcher, corn bunting, reed bunting, linnet) showed continuing decreases during the late 1990s, while four (bullfinch, skylark, song thrush, tree sparrow) can be read as roughly holding their own. On the trends illustrated in the RSPB/BTO graphs, none shows signs of achieving its target for 2008.

The 15 scarce or rare species are a more mixed bunch. With some, there are grounds for mild optimism (stone curlew, red-necked phalarope, corncrake, cirl bunting); with others, there is cause for real pessimism

RSPB IMAGES

Figure 1 **Under surveillance. Left to right: stone curlew, corncrake, roseate tern, red-backed shrike, marsh harrier and osprey. All photographs by Chris Gomersall, except the red-backed shrike (M. W. Richards).**