and oligodendrocytes in its absence[8]. Sympathetic neurons isolated from the superior cervical ganglion of neonatal rats can be grown in culture, and in the absence of other cells they are predominantly adrenergic (D.D. Potter, Harvard University). When co-cultured with heart muscle cells, they start to produce and release acetylcholine, and this effect can be mimicked by conditioned medium from cultured heart cells. Using antagonists to block both adrenergic and cholinergic receptors, further types of neurotransmitter release can be detected[9], including serotonin, adenosine and several peptides such as somatostatin and substance P. Of a repertoire of at least fifteen transmitters, individual neurons can release as many as four. The different transmitters require different stimulation frequencies and patterns for their release. The target tissue is inducing expression of particular neurotransmitter combinations, mediated in at least one case by a diffusible molecule. Here the fluid medium is carrying the 'message'. If such plasticity is seen *in vitro*, the picture *in vivo* must be even more complex.

Whole tissue mechanisms

At the single-cell level, the extracellular milieu has important signalling capacity. In tissues where signalling is most complex, and where particular cell–cell interactions are most critical, we might expect to find mechanisms for isolating the tissue milieu from other body compartments to preserve the patterns and gradients of tissue signals. This is exactly what is found in the vertebrate brain, and the compartmentation of the embryonic brain (where connections are developing) is different from that of the adult. The compartmentation gives clues about what features of the milieu need to be controlled during development.

The adult vertebrate brain is separated from the blood compartment by the blood–brain barrier and the blood-cerebrospinal fluid (CSF) barriers, but brain interstitial fluid and CSF are in continuity, and both contain low concentrations of proteins[10]. In most groups, the barrier is attributable to tight junctions between vascular endothelial cells in the brain, and epithelial cells in the choroid plexus. In the fetus, the tight junctions are similar in strand number and complexity to those of the adult (K. Møllgård, Panum Institute, Copenhagen), and appear to be as restricting to protein, although alternative routes for protein transfer across the barrier may be present (N.R. Saunders, Southampton University). Fetal CSF is high in protein, and is isolated from the brain interstitial fluid by an unusual single-stranded junction between ependymal cells lining the brain cavities, the ventricles (Møllgård). The source of the CSF protein is partly the plasma, but immunocytochemical and molecular-genetic techniques (H. Soreq, Hebrew University) show that brain cells are rich in several of these proteins, such as fetuin, albumin, α-fetoprotein and transferrin, and may be synthesizing them.

One explanation for this compartmentation is that the ependymal zone bordering the CSF (source of dividing and migrating neurons and glia) could need a high-protein medium to stimulate proliferation, whereas the brain interstitium needs a low background protein concentration so that specific proteins produced by neurons (and presumably glia) can act as effective local growth factors, morphogens and signals. The ependymal junctions gradually disappear during development, in parallel with the decline of the CSF protein concentration[11]. Effective ion regulation of the interstitial fluid and CSF comes in relatively late in development[12], presumably correlating with the maturation of excitability mechanisms and integrated synaptic activity. Thus, cell layers acting as diffusion barriers in the fetal brain seem to be designed to segregate proteins in different compartments. This suggests that the most important extracellular signals in developing brain are proteins rather than small ions. Although most developing tissues do not show the extreme isolation of compartments seen in brain, they use the same combination of diffusible and matrix-bound components for signalling and controlling differentiation. □

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Why Lake Michigan is not green

One of the abiding questions of ecology is what ultimately determines the biomass of primary producers. Asking "why is the world green?", Slobodkin, Smith and Hairston (*Am. Nat.* 101, 109–124; 1967) outlined some of the possible answers. At one extreme, it could be that predators keep herbivore populations low, so that the abundance of green stuff depends mainly on resource limitations. At the other extreme, plant biomass may be set mainly by the shifting balances in biochemical and other 'arms races' with the creatures that eat plants, with underlying resources being relatively unimportant. Anyone who has compared the teeming abundance of animal life around a coral reef with the relative quiet and vegetative lushness of a tropical rainforest will recognize that there is unlikely to be any single answer.

Many problems of environmental management require an understanding of the factors governing primary production. What, for example, should one do to prevent excessive growth of algae or other photosynthetic organisms in a lake? If the abundance of such organisms depends on nutrient input, efforts should be concentrated on preventing runoff of phosphates and other materials into the lake. But if primary production is regulated by the interactions with herbivores, and ultimately by food-web structure, one must worry about the changes likely to be wrought by the introduction of predatory fish.

As John Lehman observes elsewhere in this issue (*Nature* 332, 537–538; 1988), Lake Michigan is a case in point. Input of phosphates and other nutrients to Lake Michigan has been restricted for some time, with the aim of keeping the lake oligotrophic. At the same time, introduced salmon have reduced populations of alewife and other planktivorous fishes. Debate about the long-term effects of this combination of fishery policy and nutrient control is coloured by whether one believes the biomass of primary producers — and thence water quality — is governed mainly by nutrient input or by the structure of the food web.

Lehman provides a careful analysis of a beautiful natural experiment, which seems to answer the question for Lake Michigan. The North American Great Lakes have recently been invaded by a cladoceran predator from the Old World, *Bythotrephes cederstroemii*. Lehman compares the data for the abundance of *Daphnia* species and other zooplankton in 1985 and 1986 (before the advent of the predator) with corresponding data in 1987 (after *Bythotrephes* populations had invaded), and shows that most herbivore populations were significantly depressed. The diminished effects of herbivory, however, appear to have had no effect on the concentration of particulate chlorophyll that Lehman measured in the top 20 metres of the lake at an offshore station; Lehman reasonably assumes that this chlorophyll concentration reflects algal biomass. He thus concludes that "the maximum biomass of algae in Lake Michigan is constrained by forces of other herbivory". Apart from its relevance to a management problem of importance, Lehman's paper is exemplary in its opportunistic use of an unplanned event.

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