Neurobiology

Making of the nervous system

from R.W. Guillery and C.D. Stern

MANY conferences in the growing field of developmental neurobiology produce a plethora of facts and figures with no clear sense of direction. In a relatively new field, where the neurobiologist can still be surprised by classical concepts of embryology and may be unaware of recent cell-biological advances based on non-neural cells, this is perhaps not surprising. A recent conference* succeeded in bringing together investigators with diverse views. Although molecular biologists, the newest recruits to neurobiology, were not represented, vertebrate and invertebrate neurobiologists and developmental biologists were able to exchange views. The meeting consisted mainly of reviews of the processes that contribute to shape the nervous system, from the linkage of individual cells to activity-sharpening and cell death. It was an opportunity for those dazzled by the new techniques of molecular biology and the proliferation of messenger RNAs expressed in one or another portion of the central nervous system to be reminded of some of the basic problems that remain to be solved.

Several of the speakers bridged the gap between traditional cell biology and neurobiology. For example, microtubule-associated proteins have quite distinct and characteristic distributions in nerve cells, some associated with distinct subpopulations of tubules and some not associated with tubules at all (A. Matus, Friedrich Miescher Institute). Even early in development, neural cells are as varied as non-neural cells: neural crest and neural placode derivatives differ in their requirements for specific growth factors (R.M. Lindsay, Sandoz).

Much of the discussion centred on the subject of the existence of public or axon-specific highways that may pave the way for groups of growing axons (such as glial guides; J. Silver, Case Western Reserve University) and of diffusible molecules that may signal the location of targets. Although no revolutionary new mechanisms were revealed, some important concepts were challenged. It seems that neither laminin nor fibronectin nor their receptors are distributed in a manner that is consistent with the migration pathways of neural crest cells or segmental nerves (M. Bronner-Fraser, University of California, Irvine), and that the adhesion molecule N-CAM is not involved in either neural induction or in the guidance of axons in *Xenopus*, although it is involved in axon fasciculation and is down-regulated during the establishment of a retinotectal map (M. Jacobson, University of Utah). In an elegant search for specific markers on the surface of axonal processes, fasciculation of axons *in vitro* was found to be altered by some monoclonal antibodies but not by anti-N-CAM (J. Raper, Max Planck Institute, Tübingen). In some cases the target tissue can emit a target- and nerve-specific diffusible signal, capable of directing axonal growth, that propagates over relatively long distances *in vitro* (A.G.S. Lumsden, Guy's Hospital Medical School), and during the early stages of patterning of the peripheral nervous system, such as the early outgrowth of segmental nerves, it seems probable that inhibitory molecules prevent motor nerves and neural crest cells from entering into the wrong regions (R.J. Keynes, Cambridge University; C.D.S.).

The complexity of the vertebrate peripheral nervous system presents an aesthetically pleasing picture. Individual axons can now be differentially stained to show that some muscle fibres are always multiply-innervated whereas others replace their initial multiple innervation by a single innervation (J.W. Lichtman and D. Purves, Washington University, St Louis). Although the nervous systems of invertebrates may seem simple at first glance, detailed analysis shows that interactions between the developing parts are very complex both in insects (J.P. Bacon, University of Sussex; see the *News and Views* article on p.758) and in leeches (S. Blackshaw, University of Glasgow) and nematodes (R. Durbin, MRC Laboratory of Molecular Biology). The detailed mechanisms may not always be the same as those that operate in vertebrates. In the absence of convenient vertebrate mutations such as *minute* in *Drosophila*, simply mapping cell lineages cannot give information about lineage restrictions or the existence of insect-like compartment boundaries in vertebrates (S.E. Fraser, University of California, Irvine).

In the vertebrate central nervous system it is difficult even to define the questions, as there is much information but little theory to explain how more complex patterns are generated. The retinotectal system is a classic challenge, providing employment and frustration for many developmental neurobiologists. The formation of an accurate map involves several distinct developmental strategies, which operate coordinately (J.T. Schmidt, State University of New York at Albany; C. Stuermer, Max Planck Institute, Tübingen; J.W. Fawcett, Salk Institute). The assumption that, in producing maps, layers, columns or architectonic borders, axons compete to establish connections is challenged by the argument that competition, like embryonic regulation, might be caused in many instances by experimental interference (R.W.G.). Indeed, the possibility that by challenging a system experimentally and forcing it to perform under extreme circumstances one can start to elucidate 'normal' development can be questioned in relation to almost any problem in developmental biology. The criticism can be met only by devising sufficiently subtle and varied approaches . . ."so much concerning the several classes of Idols, and their equipage: all of which must be renounced and put away with a fixed and solemn determination, and the understanding thoroughly freed and cleansed" (Francis Bacon). □

R.W. Guillery and C.D. Stern are in the Department of Human Anatomy, University of Oxford, OX1 3QX, UK.

**The Making of the Nervous System* Wye College, Kent, UK. 8–12 July 1986.

Low-temperature physics

Pauli principle in a gas

from Peter McClintock

A NEW and macroscopic demonstration of the Pauli exclusion principle, not in the familiar quantum liquids but in a gas, has been proposed by J.P. Bouchard and C. Lhuillier. Writing in a recent issue of *Physics Letters* A (**116**, 99; 1986), they suggest a series of experiments to seek an intriguing new kind of convective instability in dilute spin-polarized gases — that is, in gases whose constituent particles have magnetic moments mostly aligned in some preferred direction (see figure).

The Pauli principle is, of course, very familiar to anyone who has ever studied chemistry. By requiring that no two electrons can ever be in exactly the same quantum state, it is directly responsible for the existence of the elements, each with its own distinct and stable electronic configuration. The Pauli principle is also of much wider applicability, however, in that it governs the behaviour of all collections of entities whose angular momenta, or spins, are half-integral. Such fermions include electrons, ^{3}He atoms, neutrons and protons. It has long been known that collections of mobile fermions can display large-scale, or macroscopic, quantum effects in the low-temperature limit, where all the available quantum states are