

to converge on a single adenyl cyclase mechanism.

The preliminary pharmacological section is followed by an informative review of modern techniques for the study of protein conformation, with discussions of the application of X-ray crystallographic methods to studies of the active site of lysozyme, and the interactions between the subunits of haemoglobin. The use of other techniques of great potential for protein studies such as nuclear magnetic resonance and the use of fluorescence probes is also described. The latter technique has already been applied to studies of conformational transitions occurring during membrane excitation following receptor stimulation. Another method which involves the use of "spin label" reporter molecules has already yielded much information on the molecular arrangement of biological membranes.

Following a description of the principles and method of affinity labelling of protein active sites, the application of this technique to receptor labelling and the consequent possibility of isolating and purifying receptor proteins form an appropriate conclusion. Such approaches, together with autoradiographic studies of drug-receptor binding, have already made most encouraging progress.

This book is, as usual for volumes in this series, excellently edited and produced. The amount of information which can be made available in less than 300 pages should serve as a paradigm for other would-be symposium organizers or editors to emulate. I thoroughly recommend this book to students of pharmacology, and molecular and membrane biology—which nowadays includes a rather high proportion of all those interested in biology. L. L. IVERSEN

Shape and Smell

Molecular Basis of Odor. By John E. Amoore. (Monograph in the Bannerstone Division of American Lectures in Living Chemistry.) Pp. xiii+200. (Thomas: Springfield, Illinois, August 1970.) \$16.50.

THIS is a personal account of Dr J. E. Amoore's research in the field of odour over the last twenty years. He has concentrated on searching for the so-called "primary odours", and his book is an enthusiastic account of the progress he has made and his gradual realization of the enormous complexity of the problems involved. Amoore now believes that there are probably 20 to 30 primary odours; by studying specific partial anosmia, he claims to have isolated a sweaty "primary odour". In particular, he has deduced from his systematic observations that isovaleric acid gives the nearest approach to a pure "primary odour" sensation. His method of deter-

ining which are the "primary odours" from specific anosmias cannot always be straightforward: indeed, he states (p. 168) that "not all specific anosmias represent primary odours".

The exact mechanism of how the odour stimulus is initiated in the sensory nerves by the odorant molecules is still a subject of controversy: Amoore believes strongly that protein receptor sites, of specificity similar to that of enzymes, are responsible. Sharply defined "primary odours" (rather like primary colours) should therefore exist.

I consider it most important at this stage of the development of odour research that really critical experiments should be devised, to try to eliminate some of the different theories in this field. This will not be easy, however, because the three leading theories of odour perception all agree that the size and shape of the odorant molecules are very important in determining odour quality. Likewise, they all agree that (for example) the musky odorants constitute a relatively well-defined class.

Amoore's account of his own theories is written in the style of a spoken lecture; indeed the material of this book was developed from a lecture course given at the University of California in April 1968. The somewhat colloquial style is, however, useful in conveying the great enthusiasm which Amoore has for his subject. This could not be said to be a textbook of odour physiology or of odour chemistry suitable for undergraduate use. But it is a book which should be read by all those who are active in research in this field, including not only medical and physiological workers, but also perfumery and insect attractant investigators. J. T. DAVIES

Neural Growth

The Formation of Nerve Connections. By R. M. Gaze. Pp. viii+288. (Academic: New York and London, September 1970.) 80s.

THE debate about whether behaviour is innate or learned has raged back and forth for many years now. Any number of people seem to have been prepared to pronounce upon this matter and, on the basis of their conclusions, to advise the public even upon such issues as the age at which potty-training should be started. Despite this universal interest, the number of those who have devoted themselves seriously to finding out whether well ordered connexions are formed in the nervous system, and if so by what mechanism, has been surprisingly small. Among this select group is Dr Gaze; his monograph, the first to be written on this important subject, is certainly welcome.

Following a brief introduction, the book is organized around four main

topics. First, the formation of connexions between nerves and muscles is discussed, opening with an informative account of the ideas and experiments of P. Weiss, the ingenious pioneer in this field. Following this comes one chapter on connexions of the somatic sensory system, and another on connexions between the retina and the optic tectum. It is here that, in recent years, perhaps the most fruitful work on the mechanisms of neural growth has taken place.

One of the difficulties in understanding how neurones make the right connexions is that the hypotheses which have suggested themselves as explanations of the effects observed seem so implausible. Only in comparison with the even greater apparent unlikelihood that development should take place at all do such explanations seem acceptable. The idea favoured by Sperry, that growing neurones recognize each other and form synapses by means of genetically determined chemical affinities, seems to have gathered most support. Gaze concludes that the great majority of neural connexions between the periphery (muscles and sense organs) and the central nervous system are formed by this mechanism. Prefunctional specification is not, however, the only possibility. Some experiments still seem to be more easily explained by Weiss's modulation hypothesis, which holds that target cells, once they are connected in the periphery, are able to send back signals along nerves to re-allocate central connexions.

None of the current hypotheses explains how patterns of interconnexion, rather than simple point-to-point arrangements, are set up. It is interesting, and perhaps significant, that some of the problems which impede our understanding of pattern recognition by the nervous system arise again in considering the problem of pattern formation within it.

In the fourth chapter, the growth of connexions between different areas within the brain is considered. One of the exciting developments here is the recent evidence from the experiments of Gaze and his associates. They suggest that within the optic tectum connexions between pairs of neurones are formed on the basis of their simultaneous stimulation by similar visual patterns from both retinæ as the animal views the world stereoscopically.

In this book, Gaze has provided both a definitive review of the subject and a point of view from which to approach it. Within the last two or three years some conceptual and experimental advances of prime importance have been made, and I think that there is no doubt that this is a field that will take even greater strides in the near future. Gaze's clear and comprehensive monograph (not to mention his own experiments) provides a fundamental contribution to this advance.

KEITH OATLEY