Invertebrate Synapses: Models and Mechanisms

The papers in this issue of the *Journal of Neurobiology* are the outcome of a symposium held at the University of Toronto on November 12, 1988, just before the 18th Annual Meeting of the Society for Neuroscience. Participants were invited to submit papers that would bring out the highlights of their recent work and emphasize the relevance of this work for the general field of neurobiology. Several "problem areas," ranging from morphology through pharmacological manipulation of second messenger systems to neural control of behavior, were emphasized. Some authors elected to conduct a review of their field of interest, whereas others stuck more closely to their recent data. Both approaches proved valuable.

This volume includes representation from the major invertebrate phylogenetic groups in which work on synapses is presently pursued. The assembled articles bring out clearly some of the advantages of exploring synapses in invertebrates. These advantages include the unique identities of selected neurons and their large size; such experimental opportunities are less frequently found in the vertebrate nervous system.

Several "high points" of these papers deserve particular mention because of their relevance for neurobiology in general. The morphological synaptic studies of Bailey and Chen, Govind and Walrond, Lnenicka and Murphey, and Atwood et al. show clearly that changes in "experience" lead to structural changes (sometimes quite rapid) that can reasonably be linked to alterations in synaptic efficacy. These observations are comparable in some respects to those postulated in the vertebrate central nervous system, but for the invertebrate examples, there is better control over the identity of the neuron and its level of experience. The work of Meinertzhagen extends the structural analysis to the developmental and evolutionary levels, illustrating the importance of the genetic "envelope" for synaptic structure. Short-term modulation of synaptic transmission by activity, neurohormones, and inhibition is examined by Bittner, Orchard et al., Drapeau and Sanchez-Armass, Gu et al., Atwood et al., and Anderson and Spencer. These papers show that there are many modulatory mechanisms available in the systems investigated, some of which are likely to be found also in vertebrates. New points of view were developed in particular by Bittner, who challenges the traditional "residual free calcium" hypothesis for short-term facilitation, and by Anderson and Spencer, who present interesting evidence against the generally accepted form of the vesicle mechanism for quantal release and who show a new type of electrical modulation of transmitter release. Mechanisms of general interest for neural development are set forth by Bulloch and Ridgway, Levine et al., and Drapeau and Sanchez-Armass. The work by Levine et al. shows clearly the role of hormonal influences in shaping neuronal morphology and the associated behavior. Aspects of neural networks and the role of synaptic properties in determining their performance are discussed by Kirk, Bailey and Chen, Anderson and

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Spencer, and Wiens. The latter brings out general roles for widespread inhibition (mediated by "common inhibitor" axons) in modifying responses of a defined network.

The symposium was organized by Harold Atwood, C. K. Govind, and Ian Orchard, all at the University of Toronto. Ian Orchard made local arrangements in the Department of Zoology for the symposium. A conference grant was supplied by the Natural Sciences and Engineering Research Council of Canada.

We list below the symposium speakers and their titles. For convenience, we have adopted a phylogenetic arrangement for this list. Most of the participants submitted manuscripts, although in some cases two participants combined their writing efforts in a single manuscript.

H. L. Atwood and C. K. Govind
Guest Editors

Coelenterates

1. *P. Anderson,* Whitney Marine Laboratory, Florida: "The Bidirectional Excitatory Chemical Synapses of the Jelly Fish *Cyanea*—Primitive Yet Highly Informative Synapses."
2. *A. N. Spencer,* University of Alberta, Edmonton: "Synchrony at a Coelenterate Neuromuscular Junction: From Currents to Behavior."

Annelids

1. *P. Drapeau,* McGill University Center for Neuroscience, Montreal: "Early Events During Synapse Formation Between Identified Leech Neurons."
2. *K. Muller,* University of Miami, Florida: "Conduction Block Modulates Synaptic Transmission in the Leech."

Molluscs

1. *C. H. Bailey,* Columbia University, New York: "Morphological Basis of Simple Forms of Learning and Memory in *Aplysia.*"
2. *A. G. M. Bulloch,* University of Calgary, Calgary: "Sprouting by Undamaged, Adult Molluscan Neurons."
3. *B. Peretz,* University of Kentucky, Lexington: "Age-sensitivity and Age-invariance of Neuromuscular Junctions in Adult *Aplysia:* Correlations Between Form and Function."
4. *M. Kirk,* Boston University, Boston: "Synaptic Interactions Among Newly Identified Premotor Neurons of the *Aplysia* Buccal Ganglia."

Arthropods: Crustaceans

1. *T. J. Wiens,* University of Manitoba, Winnipeg: "Common Versus Specific Inhibition in Decapod Crustacean Limb Muscle: Sharpened Distinctions."
2. *C. K. Govind,* University of Toronto, Toronto, and *J. P. Walrond,* Colorado State University, Fort Collins: "Structural Plasticity of Crustacean Neuromuscular Synapses."

3. *M. P. Charlton,* University of Toronto, Toronto: "Calcium Buffering and Homosynaptic Facilitation of Transmitter Release at the Crayfish Neuromuscular Junction."
4. *G. D. Bittner,* University of Texas, Austin: "Synaptic Plasticity at Crayfish Opener Excitor Synapses."
5. *G. A. Lnenicka,* State University of New York, Albany: "The Role of Activity in the Morphological Differentiation of Crayfish Motor Terminals."
6. *H. L. Atwood,* University of Toronto, Toronto: "Activity-dependent Synaptic Modification in the Crustacean Neuromuscular System."

Arthropods: Insects

1. *I. A. Meinertzhagen,* Dalhousie University, Halifax: "Fly Photoreceptor Synapses: Their Development, Evolution and Plasticity."
2. *R. B. Levine,* University of Arizona, Tucson: "Hormonal Control of the Terminal Arborizations and Synaptic Connections of Insect Sensory Neurons."
3. *I. Orchard,* University of Toronto, Toronto: "Proctolin in Insects."
4. *R. K. Murphey,* State University of New York, Albany: "The Myth of the Inflexible Invertebrate Revisited."