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EDITORIAL

Developmental, cellular and molecular neurobiology

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The second issue of the 200th volume of Experimental Brain Research is devoted to developmental, cellular and molecular neurobiology. It stands in the long tradition of the Journal, which aims at understanding complex functions of the nervous system from the mechanistic to the behavioral level. One group of papers (Bramham et al. 2010; Reid and Harley 2010; Suge et al. 2010) focuses on the molecular mechanisms of learning and memory, whereas a second group addresses questions of adult neurogenesis (Haas et al. 2010; Colditz et al. 2010) and synaptic maturation (Walz et al. 2010).

In the paper by Bramham and colleagues (2010), the role of arc in learning and memory is reviewed. It is pointed out that the transcription of the arc gene depends on changes in neuronal activity patterns. In response to these changes, arc mRNA is transported to the dendrites and locally translated by neurons. Since arc is involved in the regulation of actin dynamics and glutamate receptor trafficking at synapses, arc likely plays a critical role in the protein synthesis-dependent modification of activated synapses. Thus, arc could be a key molecule which regulates the transfer of information encoded in the form of neuronal activity into information primarily encoded in the molecular composition and structure of synapses. In addition to the well-known role of arc in synaptic plasticity, Bramham et al. also discuss a role for arc in the regulation of adult hippocampal neurogenesis. This function of arc remains poorly and incompletely understood, and the mechanistic role of arc in neurogenesis may be distinct from its role in synaptic plasticity.

The paper by Reid and Harley (2010) also focuses on the regulation of synaptic plasticity. These authors investigated the role of noradrenergic afferents from the locus coeruleus in LTP. By stimulating the perforant path and the locus coeruleus, they provide evidence that temporal proximity of locus coeruleus-associated norepinephrine release and perforant path stimulation are required to induce long-term plasticity.

In contrast to these papers, which focus on hippocampal LTP, the paper of Suge et al. (2010) investigated a hippocampus-independent form of learning: behavioral imprinting. Using c-fos expression as a marker, they demonstrated that the intermediate and medial mesopallium is involved in this form of learning in the chick.

The review by Haas and Frotscher (2010) nicely links to the first group of papers focusing on brain plasticity and memory functions. It addresses the issue, whether adult neurogenesis in the dentate gyrus—which has been introduced as a vital form of neural plasticity in the review of Bramham and co-workers—could be involved in the pathogenesis of temporal lobe epilepsy. In fact, an abnormally spread granule cell layer is frequently seen in the dentate gyrus of patients suffering from temporal lobe epilepsy and it has been speculated that this phenomenon could be caused by an abnormal migration of newly generated granule cells in the adult dentate gyrus. Haas and Frotscher (2010) not only refute this hypothesis using an experimental model of granule cell dispersion, but also provide compelling evidence that granule cell dispersion is, in fact, caused by reelin deficiency. They suggest the following sequence of events: Seizure activity decreases reelin expression in Cajal-Retzius cells in the molecular layer of the dentate gyrus. Since reelin may act as a stop-signal for

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granule cells, loss of reelin may enable mature granule cells to displace into the molecular layer, thus creating the pathological "granule cell dispersion" pattern.

Colditz and co-workers (2010) also investigated neurogenesis in the adult dentate gyrus. Using mice lacking the low-affinity neurotrophin receptor (p75 receptor), they showed that basal hippocampal neurogenesis is strongly reduced. Even under conditions of fluoxetine treatment, which is known to stimulate neurogenesis in the adult dentate gyrus, neurogenesis was only slightly enhanced. They conclude that the p75 receptor is required for the regulation of adult neurogenesis.

The issue concludes with a study by Walz et al. (2010), who analyzed the pre- and postsynaptic maturation in developing somatosensory cortex. They observe a transient existence of a novel type of functionally immature glutamatergic synapses distinct from those in the developing hippocampus. The authors hypothesize that these synapses might play a role in the activity-dependent refinement of the neocortical microcircuitry. Such a synapse could also be important in early developmental synapse elimination.

In summary, the reviews and research reports compiled in this Special Issue on developmental, cellular and molecular neurobiology cover highly interesting and "hot" topics in the field. By combining different levels of analyses ranging from the molecular to the behavioral level, the authors report novel insights into plasticity, neurogenesis and synaptic maturation. Their reports follow in the best tradition of Experimental Brain Research, a Journal devoted to understanding brain functions in depth.