Special issue on molecular and cellular cognition

The editors of *Learning & Memory* are pleased to commit this annual special issue of the journal to the topic of Molecular and Cellular Cognition for the fourth consecutive year. The nine review articles, which were invited contributions from established leaders in the field, focus on the molecular, cellular, and behavioral processes underlying learning and memory. In particular, this special issue provides overviews and in-depth analyses of the impact of stress, fear, anxiety, and circadian rhythms on learning and memory processes. In addition, reviews identify and describe neuronal circuits and neuromodulators important for learning and memory, as well as provide ideas for better ways to plan future experiments. Importantly, results from an array of molecular, cellular, electrophysiological, behavioral, and computational techniques have been used as the foundation of discussion, further emphasizing the diverse use of methods necessary for understanding the molecular and cellular basis of cognition. This special issue will be featured at the 14th Annual Meeting of the Molecular and Cellular Cognition Society and the 45th Annual Meeting of the Society for Neuroscience in Chicago, Illinois.

The special issue begins with a review by Jeankok Kim and colleagues. The authors provide a brief historical overview of the effects of stress on memory, hippocampal plasticity, and morphology, discussing both the emergence of the glucocorticoid hypothesis as well as alternative approaches to understanding the mechanisms underlying the effects of stress at the systems level. Next, a review article by Michael Fanselow and Jennifer Perusini highlights the issue that many behavioral models use the same index to measure both fear and anxiety. These authors provide a thoughtful differentiation between the two neurobehavioral states of fear and anxiety through the examination of neural circuitry and behavioral models of these conditions.

In a review article by Lisa Lyons and Harini Krishnan, a detailed discussion is provided on the impact of synchrony and desynchrony in circadian clocks on learning and memory. The authors review both molecular and morphological aspects, as well as how factors such as aging and neurodegenerative diseases are correlated with disordered circadian rhythms. Lyons and Krishnan end their review by offering countermeasures for circadian desynchrony.

Neuronal circuitry was a common theme in this issue with three review papers exploring a range of experimental methods (e.g., molecular, cellular, electrophysiological, and behavioral techniques) to better understand how specific circuits alter and modulate learning and memory processes. Susumu Tonegawa and colleagues review the role of entorhinal-hippocampal neuronal circuits in temporal associative learning and discuss how hippocampal CA1 time cells may bridge the gap between temporally discontiguous events. In a review describing the multifunctional roles of noradrenergic neurons in the locus coeruleus for learning and memory, Joshua Johansen and colleagues consider how projection specificity of this small population of cells modulates different aspects of learning though its connectivity with many brain regions, including the amygdala and medial prefrontal cortex. Minmin Luo and colleagues review results from anatomical, electrophysiological, optogenetic, and pharmacological studies examining reward processing by the dorsal raphe nucleus (DRN). Throughout the review, the authors discuss the roles of the various types of neurons in the DRN and the relative contributions of neurotransmitters in reward-related behaviors.

In two separate reviews on neuromodulation, the roles of β-adrenergic receptor signaling and sex steroid hormones on learning and memory processes are comprehensively outlined. Peter Nguyen and colleagues review the mechanisms by which β-adrenergic receptor signaling accounts for the memory-promoting effects of norepinephrine, facilitates hippocampal LTP, and modulates NMDA and AMPA receptor signaling. ERK signaling, protein synthesis, and synaptic tagging in LTP. The authors also discuss the potential of β-adrenergic receptors as a therapeutic target for treating memory disorders. In another review, Karyn Frick and colleagues describe the function of sex steroid hormones in learning and memory in male and female rodents and how they affect hippocampal morphology and plasticity. In addition, the authors outline the signaling pathways and epigenetic mechanisms by which estrogen can enhance memory in female rodents and provide practical considerations for planning experiments.

The special issue ends with a thought-provoking paper from Alcino Silva and Klaus-Robert Müller, who suggest a need for novel informatics tools for integrating and planning research in the field of molecular and cellular cognition. Silva and Müller propose ideas that could help integrate data from molecular, electrophysiological, behavioral and cognitive procedures, deriving causal connections on a large scale and creating research maps that can be used for experimental planning.

*Learning & Memory* will continue to promote research within the field of molecular and cellular cognition as it relates to learning and memory processes, as well as encourage a continued discussion and exchange of information in this ever-growing field.

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