Proceedings of the Symposium on Adaptation in Vision and Olfaction Held at the XXI Meeting of AChemS on April 15, 1999

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Adaptation is the ability of a neural system to adjust its sensitivity and dynamic range as the background level of stimulation changes. In sensory systems, adaptation increases threshold (decreases sensitivity) and extends the dynamic range of the behavioral stimulus–response function thereby allowing the system to respond to changes in stimulus intensity under different levels of background stimulation. In addition, adaptation properties of sensory receptor cells determine the magnitude of the response to the different frequency components present in a time-varying stimulus such as the odor plume sensed by an animal as it moves towards the source of the stimulus.

During the XXI meeting of AChemS, a symposium was held where four speakers discussed different aspects of the characteristics and mechanisms underlying adaptation in the visual and olfactory systems. Dr Edward Pugh Jr presented data describing calcium-dependent and independent mechanisms underlying adaptation in rod photoreceptors. His talk indicated that multiple processes underlie adaptation in rod photoreceptors. These processes can be divided conceptually into those that result in extension of the dynamic range and those that result in diminished flash sensitivity. The calcium-dependent processes best understood at the molecular level in rod photoreceptors—the activation of guanilyl cylase by calcium and the calmodulin-dependent shift in the $K_{1/2}$ of the cGMP-gated channel—contribute to extension of the dynamic range, but paradoxically elicit an increase in sensitivity, rather than a decrease. Thus, other processes must underlie the decrease in sensitivity to light flashes. Two such processes were discussed: an increase in steady cGMP hydrolysis rate and a decrease in the lifetime of activated rhodopsin. Therefore, as in the olfactory system (see below), adaptation in the visual system is a complex process with multiple underlying molecular mechanisms. Pugh and coworkers recently published an excellent review of adaptation in vertebrate photoreceptors (Pugh *et al.*, 1999).

The talk by Pugh was followed by three presentations discussing adaptation in the olfactory system from points of view ranging from molecular to behavioral. The present proceedings encompass three manuscripts covering the presentations on olfactory adaptation. The three manuscripts cover peripheral and central aspects of olfactory adaptation.

The manuscript by Zufall and Leinders-Zufall presents a comprehensive discussion of the multiple mechanisms underlying adaptation in olfactory receptor cilia. Even when considering only the initial stages of olfactory transduction in the olfactory cilia, adaptation is a complex process, whose mechanisms vary depending on duration of exposure and intensity of the adapting stimulus. The mechanisms discussed in the manuscript by Zufall and Leinders-Zufall alter the stimulus–response function that the generator potential displays as a function of odor concentration. How this change in stimulus–response function alters sensitivity of the response of mitral/tufted cells in the olfactory bulb depends on several parameters, one of which is the dependence of action potential firing frequency on the magnitude of the generator potential. Whereas the Zufall and Leinders-Zufall manuscript describes mechanisms that cause adaptation of the generator potential of receptor cells, the second paper by Reisert and Matthews discusses adaptation measured as a decrease in the action potential firing frequency. Finally, in the third manuscript, Dalton discusses psychophysical studies of olfactory adaptation in adult humans and presents evidence for the involvement of central processes in adaptation.

This series of manuscripts present a comprehensive review of recent advances in the understanding of the characteristics and mechanisms of olfactory adaptation. They indicate that adaptation is a complex process involving multiple mechanisms at peripheral and central levels of processing.

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References

Pugh, E.N. Jr, Nikonov, S. and **Lamb, T.D.** (1999) *Molecular mechanisms of vertebrate photoreceptor light adaptation*. Curr. Opin. Neurobiol. 9, 410–418.