NEURO-NEST

Seminars

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Sleep and synaptic down-selection

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Sleep is universal, tightly regulated, and many cognitive functions are impaired if we do not sleep. But why? Why do our brains need to disconnect from the environment for hours every day? The synaptic homeostasis hypothesis (SHY) states that sleep is the price we pay for brain plasticity and predicts that synaptic connections throughout the brain undergo net potentiation during wakefulness, while we learn new facts and regularities about the environment. Synaptic renormalization during sleep restores the homeostasis of energy and cellular supplies, with beneficial effects at the cellular and systems level, including memory acquisition, consolidation, integration, and smart forgetting. We will discuss the rationale underlying this hypothesis, and first summarize previous electrophysiological, molecular and genetic studies in flies, rodents and humans that confirmed SHY's main predictions. Synaptic size correlates with synaptic strength and most excitatory synapses in the cortex occur on spines. Thus, a strong prediction of SHY is that cortical spines should grow after wake and shrink after sleep, independent of circadian time. We will present recent ultrastructural results obtained in mice using serial block face scanning electron microscopy that confirm this prediction. These findings can explain why sleep is necessary for the well-being of neural cells and brain circuits, and how the regulation of synaptic strength may be a universal, essential function of sleep.