SL103 # Molecular and Cellular Mechanism of Memory
기억의 분자세포생물학

강봉균
서울대학교 유전공학연구소 분자신경생물학실

Learning and memory play a key role in the cognitive functions of the brain. The biological study of learning and memory is thought to provide an important clue to puzzle out a mystery of the mind, the integrity of human mentation. This field has grown rapidly during the last decade, keeping in step with development in molecular biology and electrophysiology. Today I will briefly summarize recent progress in memory research and also introduce gill-withdrawal reflex of the marine mollusk *Aplysia* as a model system to study learning and memory at the molecular level. Subsequently, I describe the synaptic facilitation as a cellular mechanism for short-term and long-term memory.

The modulatory neurotransmitter 5-HT plays an important role in inducing both short-term and long-term facilitation of the synaptic connections between sensory and motor neurons of Aplysia. Several processes are thought to contribute to the short-term facilitation produced by 5-HT. These include membrane depolarization, an increase in the duration of the action potential, enhanced membrane excitability, and enhanced neurotransmitter release. Our transgenic study of Ap oa_1 receptor showed that cAMP, a second messenger, is sufficient in generating the many aspects of the short-term facilitation.

The synaptic growth that accompanies 5-HT-induced long-term facilitation of the sensory to motor synapes requires the internalization of a cell adhesion molecule (apCAM) at the cell membrane of the sensory neuron. The gene transfer experiments for recombinant cell adhesion molecules (apCAM) revealed that phosphorylation of apCAM by MAP kinase is necessary for down-regulation of apCAM that is required for an initial step underlying long-term memory.

There is abundant evidence that long-term facilitation (LTF), a cellular mechanism of a reflexive memory, shares many features with long-term potentiation (LTP), another form of synaptic plasticity in the hippocampus that is thought to be involved in declarative memory. Based on the notion that synaptic plasticity is evolutionarily conserved in the nervous system, a hypothesis is suggested that there may be a molecular or cellular hierarchy that binds together the diverse memory forms. The degree of complexity in a learned information defined by the forms of memory may depend on the number of synapses that are recruited. These synapses may also be associated to one another by inter-synaptic or super-synaptic plasticity to encode complex information.