Doctoral School: **Biology Doctoral School**
Doctoral Program: Neuroscience and Human Biology

Subject code: **BIO/7/21**
Subject title: **Molecular bases of learning and memory L**
Teacher and Neptun code: **Dr. Kemenes György (I3ABYC)**
Credits: 4
Class hours: 2 hours/week, lecture

Aims of the course

Modern neuroscience research has identified plasticity manifested at the level of individual neurons ('synaptic plasticity', or 'neuronal plasticity') and brain circuits ('brain plasticity' or 'neural plasticity') as the physiological substrates for learning-induced changes in behavioural performance ('memory'). In this course students will be taught about the most relevant findings from the best known invertebrate and vertebrate model systems that have allowed us to gain a comprehensive understanding of the evolutionarily conserved cellular and molecular mechanisms of memory function and dysfunction.

Course contents

1: Basic concepts and general principles underlying the neurobiology of learning and memory. A brief history of the scientific analysis of learning and memory. A conceptual framework for investigating how memory forms, how it is encoded, maintained and retrieved ('memory function') and why and how it is impaired ('memory dysfunction')
2. The simplest forms of synaptic plasticity: presynaptic inhibition and facilitation.
3. The cellular and molecular basis of non-associative memory: habituation and sensitization of the Aplysia gill-withdrawal reflex. Cellular mechanisms of habituation and sensitization.
4. Molecular mechanisms of short-term and long-term forms of habituation and sensitization.
5. Classical conditioning of the Aplysia gill-withdrawal reflex. Basic principles of associative learning.
6. The pre-modulatory coincidence model of associative learning: activity-dependent enhancement of presynaptic facilitation. The Hebbian pre-post coincidence detection mechanism of associative learning. Molecular mechanisms of short-term and long-term associative learning.
7. Long-term potentiation and depression in the mammalian neocortex. Long-term potentiation (LTP): a long-lasting enhancement of synaptic strength.
8. Long-term depression (LTD): a long-lasting decrease of synaptic strength. A direct comparison of the molecular mechanisms of LTP and LTD.
9. Cellular/molecular analyses during and after associative learning in intact animals. Spatial memory and hippocampal LTP. Memory after fear conditioning and amygdalar LTP.
10. Classical eye blink conditioning and cerebellar LTD. Classical conditioning of the proboscis extension response in the honeybee. Classical conditioning of feeding in Lymnaea.
11. Adult brain plasticity and homeostasis. What is the function of neuronal homeostasis in the adult brain? Some examples of neuronal homeostasis.
12. Homeostatic regulation of synaptic strength and efficacy. Homeostatic structural plasticity. Systems level homeostatic plasticity.
13. Current topics in memory research. The first experimental evidence for 'lingering consolidation' from an invertebrate model. Using optogenetics to recall real or create false memories in the mammalian brain.
14. Interactive discussion of the course material.

Requirements

Course assessment: Within 2 weeks after the completion of the course, students will need to submit a 2000-word essay written in English. The essay will be based on a topic chosen by each student from a range of topics offered by Prof. Kemenes.

Literature

lecture slides are available