BIO-482

Neuroscience: cellular and circuit mechanisms

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Cursus	Sem.	Type
Biomedical technologies minor	H	Opt.
Life Sciences Engineering	MA1, MA3	Opt.
Neuro-X minor	H	Opt.
Neuro-X	MA1, MA3	Opt.
Neuroscience		Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	During the semester
Workload	150h
Weeks	14
Hours	**5 weekly**
Courses	3 weekly
Exercises	2 weekly
Number of positions	

Summary

This course focuses on the biophysical mechanisms of mammalian brain function. We will describe how neurons communicate through synaptic transmission in order to process sensory information ultimately leading to motor behavior.

Content

The brain processes information through the concerted activity of many neurons, which communicate with each other through synapses organised in highly dynamic networks. The first goal of this course is to gain a detailed understanding of the structure and function of the fundamental building blocks of the brain, its synapses and neurons. In considering this goal, we will also examine some basic methods including cellular electrophysiology and optical imaging. This will enable the student to critically evaluate how neurons are studied. The second goal is to learn how synaptic input is integrated and processed in single neurons based on the active and passive properties of axons and dendrites. Students will assemble their knowledge of synapses and neurons into a coherent picture of neuronal network function, with specific emphasis on the interactions of excitatory glutamatergic and inhibitory GABAergic neurons, plasticity and neuromodulation. The third goal, will be to place neuronal networks in the context of how they contribute to associative learning and sensory processing ultimately leading to behavioural decisions and motor output. These topics will be examined during Week 9 of the semester in a written exam.
In the second part of the semester, students will carry out a miniproject analysing a neurophysiological dataset. Students can work together in small groups (1-5 students) and must submit their miniproject report by the last Friday of the semester.
We will cover the following specific topics: Passive neuronal membrane properties; Excitability; Synaptic transmission; Glutamatergic synapses; GABAergic synapses; Dendritic integration; Synaptic plasticity; In vivo recordings; Sensorimotor integration; Sensory perception; Learning

Keywords

Neurons, synapses, neuronal networks, learning, sensory processing, motor control

Learning Outcomes

By the end of the course, the student must be able to:

- Establish a detailed understanding of the structure and function of the fundamental building blocks of the brain, its synapses and neurons.
- Discuss methods for studying brain function, including cellular electrophysiology and optical imaging.
- Describe how synaptic input is integrated and processed in single neurons based on the active and passive properties of axons and dendrites.
- Integrate cellular knowledge into an understanding of neuronal network function in the context of sensory processing.

Transversal skills

- Use both general and domain specific IT resources and tools

Teaching methods

3 h of lectures per week
2 h of exercises per week
The lectures for the first half of the course (Weeks 1-7) will be online video-lectures from the BrainX MOOC "Cellular mechanisms of brain function" hosted at edX. These videos will be accompanied by 2 hours of exercises per week.
Week 8 will be a revision week, followed by the main written exam in Week 9.
The miniproject in the second part of the semester (Weeks 10-14) will involve analysing a database of neurophysiological recordings to answer a specific set questions.

Expected student activities

Students are expected to attend the lecture and exercise sessions.

Assessment methods

Written exam in Week 9 of the semester covering the online lecture material (75% of final grade).
Miniproject submitted by the last Friday of the semester (25% of final grade).

Resources

Websites

- https://www.edx.org/course/cellular-mechanisms-of-brain-function
- https://www.epfl.ch/labs/lsens/mooc/

Moodle Link

- https://go.epfl.ch/BIO-482