BIO-311 **Neuroscience**

Ramdya Pavan P

Cursus	Sem.	Type
Computational biology minor	H	Opt.
Life Sciences Engineering	BA5, MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The course starts with fundamentals of electrical - and chemical signaling in neurons. Students then learn how neurons in the brain receive and process sensory information, and how other neurons control the behavior of an animal. Furthermore, memory, learning, and brain disorders will be introduced.

Content

- Ion channels and Electrical excitability of neurons
- Excitatory- and inhibitory synaptic transmission between neurons
- The somatosensory system and nociceptive system
- The visual system: from the retina to visual understanding
- The Auditory system
- Movement control by spinal and cerebellar circuits
- Movement control by cortex and basal ganglia
- Learning, memory, and decision-making
- Disorders of the nervous system

Keywords

neuron, ion channels, neurotransmitters, action potential, synaptic transmission, brain anatomy, sensory perception, primary sensory transduction, somatosensation, nociception, hearing, auditory system, cochlea, cochlear implant, vision, retina, primary visual cortex, nerve-muscle synapse, motor neuron, spinal cord, proprioception, reflex pathways, primary motor cortex, basal ganglia, associative learning, long-term potentiation, optogenetics, systems neuroscience

Learning Prerequisites

Required courses

Cellular and Molecular Biology II (BIO-207)

Recommended courses

General Biology (BIOENG-110); Biological chemistry I (BIO-212)

Important concepts to start the course

Basic notions of cell biology (cell membrane, phospholipid bilayers, transmembrane proteins) and of physics (electricity) would be good, but are not absolutely necessary. Curiosity and the willingness to learn about new concepts are important.

Learning Outcomes

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

- Describe the electrical properties of mammalian cells, and to draw a simple electrical equivalent circuit of cells
- Describe the mechanisms of how various classes of ion channels are gated by membrane potential changes, or extracellular/intracellular ligands.
- Describe which methods can be used to measure the electrical signaling of nerve cells.
- Describe how an action potential is generated in an electrically excitable cell, like a neuron.
- Describe how the release of neurotransmitter substances can initiate rapid inter-cellular communication between nerve cells, and from nerve cells to muscle cells.
- Describe how an appropriate physical or chemical signal from the environment can initiate membrane potential changes in sensory neurons, a process called "primary sensory transduction".
- Describe how neuronal pathways transmit specific sensory information over several anatomical subdivisions of the brain.
- Draw functional neuroanatomical schemes, in which the student places specific neurons and their long-range axons, and in which he/she can assign the principal direction of information flow.
- Describe methods how to artificially influence the electrical signaling of neurons by light, a method called "optogenetics".
- Translate his/her knwoledge by reading original research papers in topics like neuronal excitability, sensory processing, motor control, and simple forms of leaning in mice
- Reason how new knowledge of the cellular and circuit bases of simple forms of learning can be obtained in modern cellular, circuits and systems Neuroscience research.

Transversal skills

- Access and evaluate appropriate sources of information.
- Demonstrate the capacity for critical thinking
- Continue to work through difficulties or initial failure to find optimal solutions.
- Set objectives and design an action plan to reach those objectives.

Teaching methods

2h lectures per week
2h exercises per week

Expected student activities

Students are expected to attend lectures, actively engage in exercises, read the corresponding chapters in the accompanying textbook and the papers handed-out for discussion. During exercises, papers will be discussed in depth, materials reviewed, and simple computational examples will be introduced for analysis of the nervous system.

Assessment methods

Final written exam during the semester.

Supervision

Office hours	No
Assistants	Yes
Forum	Yes
Others	Moodle Forum

Resources

Bibliography

Reference textbook: Dale Purves, George Augustine et al.: Neuroscience 6th ed. 2019.
Further useful books:"Principles of Neurobiology", Liqun Luo, 2016, Garland Science, New York/Oxford.

Principles of Neural Science, Kandel, Koester, Mack & Siegelbaum 6th Edition; 2021 McGraw-Hill
Specific papers giving examples of current Neuroscience research (available on Moodle).

Ressources en bibliothèque

- neuroscience 6th ed.
- Principles of Neurobiology", Liqun Luo
- Principles of Neural Science, Kandel, Koester, Mack & Siegelbaum 6th Edition; 2021 McGraw-Hill

Notes/Handbook

Lecture materials will be available on Moodle

Moodle Link

- https://go.epfl.ch/BIO-311

Prerequisite for

BIO-480 Neuroscience: From molecular mechanisms to disease; BIO-482 Neuroscience: Cellular and circuit mechanisms