BIO-311

Neuroscience

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Cursus	Sem.	Type
Life Sciences Engineering	BA5	Opt.

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

Summary

The brain analyzes a high density of sensory information and produces well-adapted motor output, called behavior. In this course, students will start learning about the cellular- and circuit bases of sensory and motor functions of the brain, a fascinating organ which is not yet understood completely

Content

- Ion channels and Electrical excitability of neurons
- Excitatory- and inhibitory synaptic transmission between neurons
- Introduction to brain anatomy of mice and men
- The somatosensory system and nociceptive system
- The visual system
- Hearing
- Movement control by Spinal cord and brainstem
- Movement control by Cortex and basal ganglia
- Introduction to behavioral neuroscience: motivation, emotion, learning & memory

Keywords

neuron, axon, dendrite, ion channels, neurotransmitters, glutamate, GABA, action potential, synaptic transmission, brain anatomy, mouse, human, neuronal circuits, sensory perception, primary sensory transduction, somatosensation, mechanosensitive ion channel, pain, vision, photoreceptor, retina, visual thalamus, primary visual cortex, hearing, cochlea, inner hair cell, spiral ganglion, cochlear nucleus, cochlear implant, nerve-muscle synapse, acetylcholine, motor neuron, spinal cord, proprioception, central pattern generator, sensory-motor loop, reflex pathways, brainstem, upper motor neurons, primary motor cortex, basal ganglia, striatum, medial spiny neuron, instrumental learning, associative learning, long-term potentiation, optogenetics.

Learning Prerequisites

Required courses

Biologie Cellulaire et moléculaire I, II; Physique générale : électromagnétisme

Recommended courses

BIOENG-110 Biologie générale; Biological chemistry I, II (BIO-212, BIO-213)

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

Assessment methods

Written exam during the exam session

Supervision

Office hours	No
Assistants	Yes
Forum	Yes
Others	Moodle Forum

Resources

Bibliography

Dale Purves, George Augustine et al.: Neuroscience 6th ed. 2019 (or french translation).
"Principles of Neurobiology", Liqun Luo, 2016, Garland Science, New York/Oxford.
Specific papers giving examples of current Neuroscience research (available on Moodle).

Ressources en bibliothèque

- neuroscience 6th ed.
- Principles of Neurobiology", Liqun Luo

Notes/Handbook

Lecture materials will be available on Moodle

Prerequisite for

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