UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Neuroscience

2627-1-F0602Q089

Aims

A. Knowledge and understanding. The course presents a general view of the main concepts and current research fields in neuroscience, from the cellular to the system level, with a reference to some pathological implications.

B. Applied knowledge and understanding. The fundamental notions are indispensable to pursue further studies in neuropathology and pharmacology, to which reference is made during the course, where appropriate. Moreover, these notions constitute essential competences to design and interpret neurophysiological and neurobiological reserach work, in academic or industrial contexts.

C. Making judgements. A comprehension of the logic and concepts of neuroscience will enable the student to make a personal critical opinion on neuroscientific matters, even beyond the specific topics of the course. The critical judgment is refined by comparing different textbooks as well as research and review articles distributed during the course and discussed with the teacher.

D. Communication skills. The student will learn to properly communicate the neuroscientific concepts and notions. This capacity is developed bypersonal study, interaction with the teacher and verified during the oral exam.

E. Learning skills. The personal understanding acquired is necessary to proceed with personal studies on affine disciplines.

Contents

1. Introduction and evolutionary aspects.
2. Cell neurophysiology.
3. Synaptic physiology and local neuronal circuits.
4. Integration and control of cerebral functions.
5. Some neuropathological implications.

Detailed program

Introduction. Evolution of the nervous systems of Vertebrates and Invertebrates. Experimental models in Neurobiology.

I) Selected topics in cell neurophysiology.

Main cell types, fundamentals of neurophysiology, molecular motors in the neuron. Blood-brain barrier. Control of pH and extracellular K+ in the CNS. Peculiar aspects of cerebral metabolism: neuron-glia interaction. Volume regulation: role of glial cells, volume control in gliomas.

II) Synaptic physiology and local neural circuits.

Historical introduction. Fundamentals of glutamatergic, GABAergic and peptidergic transmission. Cellular basis of learning and memory.

Orientation and navigation. Role of the hippocampus. Local circuits. Cell diversity in the cerebral cortex. Laminar organization. Microcolumns.

Pathological implications: molecular and cellular mechanisms of epilepsy.

III) Integration and control of brain functions

Ascending modulatory systems. Mood control. Biological rhythms and environment. Suprachiasmatic nucleus, photoperiod. Sleep-waking cycle in the Animal Kingdom. Sleep in mammals and birds. Reticular system. Thalamocortical system.

Sensory Systems: general aspects and signal coding. Psychophysics and sensitivity. Adaptation. Central elaboration. Sensory cortices. Granular cortices. Associative areas. The 'binding' problem.

Motor Systems. Hyerarchical levels of control. Motor execution, error correction and learning. Motor schemes and locomotion. Cerebellum (hints). Motor and premotor regions. Agranular cortices. Pyramidal tract. Motor coding. Motor cortex plasticity. Premotor regions and mirror neurons. Volition and motor acts.

Neuropathological implications: autism and schizophrenia.

Prerequisites

General concepts of General and Systems Physiology (especially cell physiology, the mechanisms of excitability, and the physiology of excitatory and inhibitory synapses).

Fundamentals of Neuroanatomy (general organization of the nervous system in vertebrates).

Teaching form

21 lessons (2 hours each); format: lecture in-person.

The course will be held in English.

The lessons will be video-recorded and made available through e-Learning, along with the slides, articles and other documents (via Forum).

Textbook and teaching resource

Pdf files (slides and articles) and registered lessons will be distributed through e-Learning.

Reference textbooks:

Kandel et al., Principles of Neural Science, McGraw-Hill 2021 (VI edition, but the previous edition is also appropriate)

Brady et al. Basic Neurochemistry, VIII edition. Academic Press, 2012.

Martin et al., From Neuron to Brain, VI edition. Sinauer-Oxford University Press, 2021.

Swanson. Brain Architecture, I or II edition. Oxford University Press (E-book version available in our library).

Other texts or reviews useful for specific topics will be mentioned during the course.

Semester

First semester

Assessment method

Oral exam. There are no in itinere tests.

The exam begins with the student presenting a topic of his/her choice, among those treated during the course.

Next, the discussion is extended to other topics, to evaluate the student's comprehension of the main concept of modern Neurosciences and the capability of connecting different complementary issues. For instance, beginning from the alterations of excitability and synaptic function observed in epilepsy models, one can extend the discussion to the fundamental features of the local organization of neocortex or hippocampal circuits.

The exam may be held in English.

Office hours

Appointment by E-mail (andrea.becchetti@unimib.it)

Sustainable Development Goals

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