UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Physiology 2

**2021-2-H4101D253-H4101D022M**

## Aims

It is essential that all medical students receive sufficient exposure to the physiological concepts underlying the functions of the human body that will provide the basis for further studies in pharmacology, pathology, pathophysiology and medical clinics and surgery. Curricular objectives are mainly focused on the normal function of the body, however, the material is presented in a context that prepares students for their role as doctors. Therefore, whenever possible, clinical examples will be used to illustrate physiological baseline principles.

## Contents

The course is based on the systematic presentation of physiological concepts based on the functions of the human body. The mechanism leading to an imbalance of function cannot be appreciated without a deep understanding of the biophysical and physiological basics. Therefore, such mechanisms that ensure the functions at the cellular level, tissues, organs and apparatus and at the integrated level will be introduced. In particular, the course will address the physiology of the respiratory and nervous system, motor functions and superior nervous functions.

## Detailed program

### NEUROPHYSIOLOGY

Physiology of nerve cell - cell excitability Plasma membrane. Permeability, diffusion, osmosis, active and passive transport across the membrane. Ion channels. Electrochemical balance and Nernst equation. Resting membrane potential. The Na + / K +pump. Passive electrical
properties of the membrane. Action Potential: origins, bases and ionic properties. Conduction of the action potential in unmyelinated and myelinated nerve fibers. Classification of nerve fibers. Elementary interactions between excitable cells. The synapses. General concepts on

the synaptic transmission. The neuromuscular junction. The central synapses. Electrical events in postsynaptic neurons (EPSP and IPSP). Synaptic plasticity, LTP and LTD. Neuronal integration of synaptic inputs: spatial and temporal summation. Neurotransmitters, agonists and antagonists in the CNS. The BFCS, memory and aging. Definition and classification of motor units. Modulation of force output by varying the firing rate and recruitment of motor units. The nervous system - Sensory Systems. Organization and general mechanisms. The sensory receptors: definition and classification of receptors. Signal transduction and coding. Adequate stimulus. Adaptation. Receptive fields: mode, location, intensity, duration. Structure of human sensory system: free nerve endings, the nociceptors and thermoreceptors. Ascending pathways of somatic sensibility: the dorsal column-medial lemniscus system, the anterolateral system (spinothalamic tract). Somatosensory cortex. The pain. Nociceptors: anatomical distribution, mechanisms of activation and sensitization Nociceptors somatic, deep and visceral. Central pathways of pain sensibility. Endogenous antinociceptive systems: spinal mechanisms of modulation and supraspinal descending inhibitory systems. Opioids. Special sense organs. Motor system control: neuronal circuits, reflex responses, voluntary movements and rhythmic activities. Organization of motor system: spinal cord, brainstem and cerebral cortex. Cerebellum and basal ganglia. The medial and lateral systems in motor control. Motor functions of the spinal cord: spinal reflexes, muscle spindle and the stretch reflex, inverse stretch reflex, flexor reflex, the spinal preparation. Motor functions of the brainstem and cortex; supraspinal control of the stretch reflex, posture and its maintenance. Vestibular and neck reflexes. Cortical control of movement. Motor areas of the cortex and their functional role. Cerebellum and basal ganglia: general organization and functional role in motor control. Autonomic nervous system. Anatomical and functional organization of the sympathetic and parasympathetic system. Chemical mediators. Organization of the autonomic reflexes. Vegetative functions of the brainstem. Central nervous control of visceral functions. The neurovascular Unit and blood brain barrier functions.

**RESPIRATORY SYSTEM.**

Lung volumes and partial pressure. Methods for the measurement of pulmonary volumes. Spirometry: static lung volumes. Fowler's method for calculating anatomical dead space. Dilution and plethysmographic method for calculating the residual volume. Dalton's law. Composition of ambient, inspired and alveolar air. Solubility of plasma gases and oxygen binding with hemoglobin. Henry's law. Fick's law for the diffusion of alveolar gases. Concepts of diffusion and perfusion limitation. Diffusive capacity. Diffusion capacity measurement method (DLCO). Physiopathological alterations of DLCO and its subcomponents. Transit time in the pulmonary capillary. Transport of O2 into the blood. Hemoglobin dissociation curve. Fick's principle. Alterations of O2 transport capacity in anemic patient, at high altitude and in physical exercise. Affinity variation of the hemoglobin dissociation curve as a function of physical and physiological parameters. Carbon monoxide toxicity. CO2 transport in the plasma. Bohr effect. Haldane effect. Bicarbonate buffer. Buffer power of hemoglobin. Acid-base balance. Diagram of Davenport. Acidosis and alkalosis, metabolic and respiratory. Ventilation-perfusion ratio. Regional variations of the VA report

**Practise:**

Blood pressure. Sphygmic wave. Peripheral vascular resistance. Control by the sympathetic nervous system and circulating catecholamines. Arterial pressure in the different districts of the cardiovascular system. Systolic, diastolic and mean arterial pressure. Measurement of arterial pressure.

Electrocardiogram: Reading and interpretation of a physiological electrocardiogram

## Prerequisites

Knowledge of the introductory courses indicated in the guidance of the degree course

## Teaching form

Lectures. Whenever possible, clinical case analyzes will be proposed for the evaluation of the specific physiological

parameters. Laboratories. The teaching methods will include lectures, videos, and class discussions.

In the first semester the courses will be delivered in mixed mode from asynchronous remote with synchronous videoconferencing events (WEBEX)

## Textbook and teaching resource

E. R. Kandel, J. H. Schwartz, T. M. Jessel, S. A. Siegelbaum, A. J. Hudspeth, PRINCIPLES OF NEURAL SCIENCE, Mc Graw Hill Medical

Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel LaMantia, Richard D. Mooney, Michael L. Platt, NEUROSCIENCE (6th Edition) – eBook - Sinauer Associates (Oxford University Press); 6th edition

Susan E. Mulroney, Adam Myers, NETTER'S ESSENTIAL PHYSIOLOGY, Elsevier

Belfiore et al., FISIOLOGIA UMANA - FONDAMENTI, edi-ermes

D’angelo, Peres, FISIOLOGIA, edi-ermes

Conti, FISIOLOGIA MEDICA, edi-ermes

Guyton & J.E. Hall, FISIOLOGIA MEDICA, Piccin

Allan Siegel, Hreday N Sapru, FONDAMENTI DI NEUROSCIENZE, Piccin

Klinke, FISIOLOGIA, EdiSES

Grassi, Negrini, Porro, FISIOLOGIA MEDICA, Poletto Editore

Miserocchi G. FISIOLOGIA E FISIOPATOLOGIA RESPIRATORIA, CEA

Mc Ardle, Katch, Katch, FISIOLOGIA APPLICATA ALLO SPORT, CEA

## Semester

Second semester

## Assessment method

There will be no ongoing tests. The exam consists in an oral test. Open questions will be posed to the student in order to evaluate the general knowledge of the topics. Moreover, the student will be asked to answer to questions that require the analysis of a complex phenomenon, its rationalization and the application of specific physiology principles and to solve simple exercises. Finally, a clinical case may be presented which will require the analysis of the interconnections between different physiological variables in the light of the theoretical paradigms.

During the Covid-19 emergency, oral exams will only be online. They will be carried out using the WebEx platform and on the e-learning page of the course there will be a public link for access to the examination of possible virtual spectators.

## Office hours

The professors receive by appointment upon agreement by e-mail