UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Fisiologia Umana 1 A

2627-2-H4103D007-H4103D00701

Aims

The **Cell and Renal Physiology** module aims to provide students with fundamental knowledge of the physiological mechanisms underlying basic cellular functions and the maintenance of water-electrolyte and acid-base homeostasis. By the end of the module, students are expected to understand the principles regulating transport across the plasma membrane, membrane potential, cellular excitability, synaptic transmission and excitation-contraction coupling in different types of muscle tissue. Students are also expected to understand the functional organization of the renal system, the mechanisms of glomerular filtration, tubular reabsorption and secretion, urine concentration and dilution, assessment of renal function through clearance measurements, and the role of the kidney in the regulation of water-salt, electrolyte and acid-base balance.

Contents

The module covers the basic **principles of cell physiology**, with particular reference to membrane transport, ion channels, transporters, membrane potential and electrical events in excitable cells. The mechanisms of synaptic transmission, electrical and chemical synapses, neurotransmitters, postsynaptic potentials and synaptic integration will be discussed. The neuromuscular junction, the physiology of smooth, skeletal and cardiac muscle contraction, and the main mechanisms of excitation-contraction coupling will also be addressed.

Regarding **renal physiology**, the module will cover body fluid compartments, water-salt homeostasis, the role of antidiuretic hormone, natriuretic peptides and aldosterone, the functional structure of the nephron, glomerular filtration, tubular reabsorption and secretion. The mechanisms of urine concentration, the countercurrent multiplication system, the concept of renal clearance and the role of the kidney in acid-base regulation will also be discussed.

Detailed program

The module introduces the general principles of cell physiology, with particular attention to exchanges across the plasma membrane. The main transport pathways will be analysed, including simple diffusion, facilitated diffusion, passive transport and primary and secondary active transport. The role of membrane transporters, ion channels and the sodium-potassium pump in maintaining ionic gradients and cellular homeostasis will also be described.

Part of the module will focus on basic electrophysiology. Membrane potential, the electrical properties of the cell membrane, the electrical model of the membrane, the equilibrium potential of an ion according to the Nernst equation, and the contribution of different ions to the resting membrane potential will be discussed. Electrical events in excitable cells will then be described, with particular reference to the action potential, its phases, the ionic mechanisms underlying it and the propagation of the nerve impulse.

The module will continue with the study of synaptic transmission. The main features of synapses in the central nervous system will be presented, distinguishing between electrical and chemical synapses. Neurotransmitter release, activation of postsynaptic receptors, generation of excitatory and inhibitory postsynaptic potentials, mechanisms of synaptic facilitation and inhibition, and spatial and temporal summation will be described.

The neuromuscular junction and the mechanisms linking synaptic transmission to skeletal muscle contraction will then be addressed. The principles of muscle contraction physiology will be analysed, with reference to skeletal, smooth and cardiac muscle. Particular attention will be given to excitation-contraction coupling in striated and cardiac muscle, highlighting the common features and the main functional differences among the different types of muscle tissue.

The second part of the module will focus on renal physiology. Body fluid compartments and the principles of water-salt and electrolyte homeostasis will be introduced. The role of antidiuretic hormone in water balance regulation, natriuretic peptides in extracellular volume control and aldosterone in sodium and potassium balance will be described.

The main functions of the renal system and the neural control of renal function will then be presented. The organization of the nephron, the renal corpuscle and the ultrastructure of glomerular capillaries will be described. Particular attention will be devoted to glomerular filtration, the glomerular filtration coefficient, the Starling forces regulating filtration and the glomerular filtration rate.

The module will examine the factors influencing glomerular filtration rate and the intrinsic mechanisms controlling filtration, with reference to myogenic regulation and tubuloglomerular feedback. Tubular reabsorption, tubular secretion and the main functions of the different tubular segments will also be discussed.

A specific section will focus on the mechanisms of urine concentration and dilution. The minimum obligatory urine volume, the maximum concentrating ability of the kidney, the countercurrent multiplication mechanism and the processes involved in the generation and maintenance of the medullary hyperosmotic gradient will be described, including medullary perfusion and urea recycling.

The concepts of clearance and renal function will then be introduced. The definition of clearance, the calculation of clearance for a given compound, inulin clearance for the assessment of glomerular filtration rate, para-aminohippurate clearance for the estimation of renal plasma flow, osmolar clearance and free water clearance will be discussed.

Finally, the module will address the role of the kidney in acid-base regulation. The principles of the Henderson-Hasselbalch equation, the main chemical buffer systems and the physiological compensatory mechanisms against acid-base disturbances will be reviewed. Renal mechanisms involved in pH regulation will be analysed, including bicarbonate reabsorption, hydrogen ion secretion and the use of urinary buffer systems, particularly phosphate and ammonia.

Prerequisites

The prerequisite requirements to be fulfilled in order to sit the Human Physiology exam are those indicated in the Teaching Regulations of the Medicine and Surgery degree programme for the 2026/2027 academic year.

Teaching form

All lessons of 2 hours each will be in person, except in emergencies. They will begin with an initial part where concepts will be presented (lecture-based mode), followed by interaction with students that defines the subsequent part of the lesson in interactive mode.
Teaching methods will include lectures, videos, and class discussions.
Teaching activities may include, up to a maximum of 30% of the total lecture hours, the use of innovative teaching methods, including delivery under the supervision of the lecturer, co-teaching arrangements and/or remote teaching, in accordance with Ministerial Decree No. 1835 of 6 December 2024.

Textbook and teaching resource

Please refer to the general course syllabus.

Semester

Second year, First Semester

Assessment method

For the assessment method, please refer to the general course syllabus.

Office hours

The professor receives by appointment upon agreement by e-mail
ilaria.rivolta@unimib.it

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | GENDER EQUALITY | REDUCED INEQUALITIES