

HUMAN PHYSIOLOGY

Degree in Occupational Therapy

Code: 804145

Type of subject: Basic

Grade: First

Semester: Check calendar

Department: Physiology

Credits: 9 ECTS

TEACHING STAFF

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OBJECTIVES

- The primary objective of Physiology Course is to ensure that students understand how the body works.
 - Define homeostasis and explain how homeostatic mechanisms maintain a constant interior milieu.
 - Know the control of the different physiological systems by the autonomic nervous system.
 - Describe blood composition and the role of the different blood cells (erythrocytes, leukocytes) and plasma components (platelets, pro- and anti-coagulant factors) in blood flow (e.g. haematocrit) and haemostasis, as well as those of the immune system.
 - Understand the functioning of the heart and the various vessels, having analysed the physical laws governing the circulation of blood in the cardiovascular system.
 - Explain the primary functions of the respiratory system and the physical principles that govern the movement of air into the lungs and the diffusion of gases into and out of the blood. Demonstrate how to measure and analyze lung capacities. Exhibit how gas transport affects blood pH. Understand the control of breathing.
 - Explain the basic functions of the kidney and urinary system with the aim of understanding the relationship between the structure and function of its various components. Know the role of kidney physiology in blood pressure, electrolyte, and fluid homeostasis.
 - Understand the functioning of the gastrointestinal system, having studied the functions of digestion, secretion, motility and absorption that occur in each section of the digestive system.
 - Integrate the role of the various axes of the endocrine system as regulators of many physiological processes.
- Describe the general functional organization of the nervous system as a regulatory system. Study the basic characteristics of nervous tissue and neurons: membrane potential and synaptic transmission.
 - To understand the organization and function of sensory systems and the basic mechanisms of perception: sensory transduction, receptor fields, sensory threshold, sensory maps (somatotopic, retinotopic...).
 - Describe the general characteristics of the different sensory modalities: somaesthesia and special senses (taste, smell, hearing, balance, vision).
 - To understand the general functional organization of motor control systems. Study the basic characteristics of muscle contraction and the motor unit.
 - Describe the general characteristics of the different areas involved in the control of the somatic motor system: spinal cord, brainstem, cerebral cortex, basal ganglia and cerebellum.
 - Study the regulatory systems of the sleep-wake cycle.
 - To understand the neurobiological mechanisms of learning and memory. To understand the different memory systems.

PROGRAM

THEORETICAL

Topic 1. Introduction to human physiology.
Concept. Levels of organization of the human body.
The internal environment. Homeostasis and control systems.

Autonomic Nervous System

Topic 2. Autonomic nervous system.
Organization of the nervous system. Structure of the autonomic nervous system. Parasympathetic nervous system.
Sympathetic nervous system. Functions of the autonomic nervous system.

Cardiovascular System

Topic 3. Introduction to the cardiovascular system.
Elements of the cardiovascular system. The heart valves. Functional structure of the cardiovascular system. Flow in the cardiovascular system.
Arrangement of the systemic circulation. Differences in organ perfusion.

Topic 4. Cardiac electrical activity.
Cardiac muscle. Pacemaker cells. Propagation of cardiac electrical activity. Sequence of contraction
Electrocardiogram.

Topic 5. Cardiac cycle. Cardiac output.
Mechanical events of the cardiac cycle. Cardiac output. Control of heart rate and stroke volume.

Topic 6. Arteries
Functional structure of the arterial wall. Arterial distensibility and elasticity. Arterioles. Arterial pressure, factors on which it depends. Normal arterial blood pressure values.

Topic 7. Capillaries and lymphatic system
Capillaries and lymphatic system.
Structure and characteristics of capillaries. Capillary exchange. Lymphatic circulation.

Topic 8. Veins.
Functional structure of veins. Venous return.

Topic 9. Integration of cardiovascular function.
Local regulation of blood flow. Short-term blood pressure regulation. Arterial baroreceptors. Long-term regulation of arterial pressure.

Haematology

Topic 10. Properties of blood. Functions.
Composition. Haematopoiesis.

Topic 11. Red blood cells.
Structure and function. Erythropoiesis. Red blood cells cycle life. Regulation of erythropoiesis.

Topic 12. Leukocytes and immunity.
Types of leukocytes. Leukocyte formation. Functions of leukocytes. Innate immunity or non-specific:

phagocytosis, inflammation, NK cells, fever. Specific immunity: humoral immunity, cell-mediated immunity. Blood groups.

Topic 13. Platelets and haemostasis.
Platelets. Haemostasis. Platelet plug formation. Fibrin network formation. Fibrinolysis.

Respiratory System

Topic 14. Organization of the respiratory system.
The airways and blood vessels. Lungs and the thoracic chest wall relations. Pleural sacs.

Topic 15. Ventilation and Lung Mechanics.
Inspiration and expiration. Lung compliance, airway resistance. Lung volumes. Pulmonary and alveolar ventilation.

Topic 16. Gas exchange.
Partial pressures of gasses. O₂ and CO₂ exchange between alveoli and blood and between tissues and blood.

Topic 17. Transport of gases.
O₂ and CO₂ transport: role of hemoglobin. Hypoxia.

Topic 18. Control of breathing.
Neuronal respiratory centres. Control of ventilation by O₂, CO₂ y H⁺ concentration. Other ventilator responses.

Renal Physiology

Topic 19. Introduction to the renal system.
Structure of the kidney: the nephron as a functional unit.

Topic 20. Basic kidney functions. Glomerular filtration, tubular reabsorption and secretion.
Regulation of sodium, water and potassium.
Renin-Angiotensin system and antidiuretic hormone.
Acid-Base balance.

Topic 21. Micturition
Urinary system. Micturition reflex.

Digestive System

Topic 22. Function and processes of the digestive system. Structure of the gastrointestinal tract wall.
Nutritional needs of the organism.

Topic 23. The oral cavity.
Chewing. Components and function of saliva.
Regulation of salivary secretion.

Topic 24. Swallowing.
Esophageal peristalsis. Lower esophageal sphincter regulation.

Topic 25. The stomach.
Composition of gastric secretion. Functions and regulation of gastric secretion. Gastric motility.
Regulation of gastric function.

Topic 26. The exocrine pancreas.
Composition of pancreatic secretion.
Regulation of pancreatic secretion.

Topic 27. The liver.

Composition of bile. Regulation of bile secretion.

Topic 28. The small intestine.

Structure of the small intestine. Intestinal secretion: composition and regulation. Motility of the small intestine. Intestinal reflexes.

Topic 29. Absorption of nutrients.

Absorption of water and electrolytes. Absorption of carbohydrates. protein absorption, absorption of lipids and absorption of vitamins

Topic 30. The large intestine or colon.

Secretion and absorption in the colon. Motility of the large intestine. Defecation.

Endocrine System

Topic 31. Introduction to the endocrine system.

Types of cell communication. Hormones structure, Mechanisms of hormone action. Regulation of hormone secretion.

Topic 32. The hypothalamus and pituitary gland.

Control systems involving the hypothalamus and pituitary. Posterior pituitary hormones. Anterior pituitary hormones and the hypothalamus. Endocrine axis.

Topic 33. Hormones of the neurohypophysis.

ADH and oxytocin. Functions of oxytocin. Regulation of oxytocin secretion.

Topic 34. Hypothalamic-pituitary-hepatic axis: growth hormone.

Physiological actions of growth hormone. Regulation of growth hormone secretion. Most common pathologies.

Topic 35. Hypothalamic-pituitary mammary axis: prolactin. Physiological actions of prolactin. Regulation of prolactin secretion.

Topic 36. Hypothalamic-pituitary-adrenal axis.

Structure of the adrenal glands. Adrenal steroids. Functions of glucocorticoids.

Regulation of glucocorticoid secretion. Adrenal medulla.

Topic 37. Hypothalamic-pituitary-thyroid axis.

Structure of the thyroid gland. Biosynthesis of thyroid hormones. Biological actions of thyroid hormones.

Regulation of thyroid function. Most common pathologies.

Topic 38. Hypothalamic-pituitary-testicular axis.

Male reproductive system. Spermatogenesis and testicular steroidogenesis. Physiological actions of androgens.

Regulation of the hypothalamic-pituitary-testicular axis.

Topic 39. Ovarian hypothalamic-pituitary axis.

Female reproductive system. Ovogenesis and ovarian steroids. Ovarian hypothalamic-pituitary axis. Menstrual cycle and its regulation. Actions of oestrogens and progestogens. Menopause. Pregnancy and lactation. Contraception.

Topic 40. Endocrine pancreas.

Physiological actions of insulin. Biological actions of glucagon. Regulation of calcaemia. diabetes mellitus

Topic 41. Regulation of calcium metabolism.

Physiological actions of parathormone.

Functions of calcitonin. Role of vitamin D in the regulation of calcaemia.

Nervous System

Topic 42. Introduction to the nervous system.

Functional organization of the nervous system.

Topic 43. Nervous tissue.

Cells of the nervous system. The resting membrane potential, graded potentials and action potentials. Synapses.

Topic 44. Introduction to sensory physiology.

General properties of sensory systems.

Functional organization of sensory systems.

Sensory modalities.

Sensory receptors: classification, sensory transduction. Coding of stimulus information and perception: receptive fields, sensory threshold, sensory maps.

Topic 45. Somatic sensation

Somatosensory receptors and modalities.

Somatosensory pathways: dermatomes and primary afferents. Thalamus. Primary and secondary somatosensory cortex (somatotopic map). Posterior parietal cortex.

General characteristics of exteroception (touch-pressure and temperature) and proprioception.

Nociception. Hyperalgesia. Ascending and descending pathways.

Topic 46. Chemical senses: taste and smell.

Primary qualities of taste. Taste buds. Taste pathways. Taste coding. Olfactory epithelium. Olfactory pathways. Coding of odours.

Topic 47. Hearing and equilibrium.

Structure of the inner ear: cochlea and vestibular system. Sound transmission. Cochlea and organ of Corti. Auditory pathway and cortex (tonotopy). Hearing loss. Otolithic organs and semicircular canals. Maculae and ampullary cristae. Vestibular pathways. Vertigo.

Topic 48. Vision.

Optical system: the eye. Pupillary and accommodative reflexes. Optical defects. The retina: photoreceptors. Visual field and visual pathways. Primary and secondary visual cortex (retinotopia). Colour vision.

Topic 49. Introduction to motor control systems.

General characteristics of motor control. Hierarchical organization. Motor unit. Neuromuscular junction. Muscle contraction.

Topic 50. Spinal cord and brainstem

Spinal reflexes. Muscle tone. Motor programmes for walking. Postural control: reticular and vestibular nuclei.

Topic 51. Motor cortex.

Primary motor cortex. Corticospinal and extrapyramidal pathways. Premotor cortex. Supplementary motor area: planning of motor behaviour.

Topic 52. Basal ganglia and cerebellum.

Structure and function of the basal ganglia: motor, cognitive and limbic circuits. Related pathologies: Parkinson's disease and Huntington's disease. Structure and function of the cerebellum. Ataxias.

Topic 53. Language and cerebral dominance.

Centers for language function.

Topic 54. The limbic system.

Emotion and motivation. Neural mechanism of conscious experiences. Amygdala as center for basic instincts such as fear and for learned emotional states.

Topic 55. Sleep-wake cycle.

Characteristics of sleep. Sleep criteria. Slow and REM sleep. Sleep-wake cycle regulation systems. Sleep disturbances. Sleep functions.

Topic 56. Learning and memory.

Types of learning. Types of memory. The neural basis of learning and memory. Brain areas involved.

PRACTICAL / SEMINARS

Practical classes will be carried out in the laboratories of the Department of Physiology (Faculty of Medicine).

The student will have the scripts of the practice in the virtual campus. The following practices will be taught:

- Calculation of hematocrit value and blood groups.
- Blood pressure and heart rate at baseline and after exercise.
- Spirometry.
- Body composition.
- Hearing
- Neurological examination.

In the seminars, practical problem solving and case studies will be carried out.

TUTORIALS

The teaching, both on-site and virtual, will personally attend to students to supervise their training, guide them and resolve any doubts that may arise. In the case of face-to-face tutoring, it will be a prerequisite to arrange it in advance with the professor.

EVALUATION CRITERIA

- During the course there will be 4 partial exams. The value of each exam will represent 25% of the final grade.
- All exams will consist of a test with 4 answers, only one of which will be correct.
- The exams will include questions related to the theoretical and practical subjects.
- The final grade for the course will be the arithmetic mean of the grades obtained in each session.

Passing the course by mid-term exams

- To pass the course by mid-term exams, ALL exams must be passed.

Ordinary (June) and Extraordinary (July) exams

- Students who fail any of the 4 exams will have a maximum grade of 4.5 (fail), and will have to take the exams they have failed. The grade of the exams passed will be kept for the ordinary (June) and extraordinary (July) exams.
- Students who do not pass ALL the course in the extraordinary exam will have a maximum grade of 4.5 (fail) and will have to repeat the course.

BIBLIOGRAPHY

- Costanzo L. (2018), Fisiología (6ª ed.), Elsevier
- Gal (2007) Bases de la Fisiología, 2ª ed. Editorial Tebar.
- Ganong (2020), Fisiología Médica, 26ª ed., Manual Moderno.
- Mulrone & Myers (2016), Netter. Fundamentos de Fisiología. 2ª ed. Ed. Elsevier.
- Silverthorn, D.U. (2019). Fisiología Humana. Un Enfoque Integrado. 8ª ed. Ed. Panamericana.
- Thibodeau & Patton (2012), Estructura y función del cuerpo humano, 14ª ed., Editorial Elsevier Mosby.
- Tortora & Derrickson (2018), Principios de anatomía humana y fisiología, 15ª ed., Editorial Panamericana.
- Tresguerres, Villanúa & López-Calderón (2009), Anatomía y fisiología del cuerpo humano, Editorial McGraw-Hill.
- In the library you can access some of these texts with the following link: <https://biblioguias.ucm.es/grado-terapia-ocupacional/fisiologia-humana>