

PHYSIOLOGY

Degree in Human Nutrition and Dietetics (2026/27)

Code: 803975

Module: 1

Course: Physiology

Type of course: Obligatory (Basic)

Year: First

Semester: Second (Check calendar)

Department: Physiology

Credits: 9 ECTS

FACULTY

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SHORT DESCRIPTION

Throughout the course and the study of the Physiology subject, several methodologies will be addressed:

- **Theoretical classes** in which the necessary explanations will be addressed to understand how the systems that make up the human body work.
- **Seminars** on the days indicated for this purpose, in which problems will be solved, doubts will be clarified, or the most difficult issues will be emphasized. Multiple choice questions will also be asked to familiarize the student with the methodology that will be part of the subject exams (evaluation method).
- **Laboratory practices** that will deal with some of the topics explained in the theoretical classes.

COMPETENCES

They are those corresponding to the Module and Subject to which this course belongs to.

General Competences

- C.G.1.1.
- C.G.1.2.
- C.G.1.3.

- C.G.1.4.
- C.G.2.1.
- C.G.2.2.
- C.G.2.3.
- C.G.8.1.

Specific Competencies

- CE.M1.1.
- CE.M1.2.
- CE.M1.5.
- CE.M1.7.
- CE.M4.22.

OBJECTIVES

- Know how the healthy organism works and its regulatory mechanisms.
- Study the activity of the different systems that keep the human being alive.
- Become familiar with and analyze the complex activity of a healthy organism.
- Know the functions of the blood, the cardiovascular system and the respiratory system, the activity of the digestive system and the renal system, and the general regulation carried out by the endocrine system and the nervous system

SYLLABUS

THEORETICAL LESSONS

Introduction

Lesson 1. Introduction to human physiology.

Definition of Physiology. Levels of understanding of physiology: Molecular, cellular, organ and systems, and integrated physiology. Contents of Physiology at the Faculty of Medicine (UCM). Concept of homeostasis.

General Physiology and Physiology of the Autonomic Nervous System.

Lesson 1. Body fluids. Definition of body compartments. Distribution of body water. Determination of fluid volume in different compartments. Body water balance. Composition and osmolarity of intracellular, interstitial and plasma fluids. Exchange of water and solutes between plasma and interstitial compartments. Variations in volume and osmolarity of extracellular and intracellular compartments. Lymph: composition, flow, function. Cerebrospinal fluid: composition, flow, function.

Lesson 2. Electrical potentials. Introduction. Resting membrane potential. Electric current and ion movement across the membrane. Changes in membrane potential. Local or graded potentials. Action potential: definition, characteristics, generation and propagation.

Lesson 3. Synaptic transmission. Introduction. Types of synapses. General characteristics of chemical transmission. Neurotransmitters. Synapses between neurons: postsynaptic potentials. Neuromuscular junction.

Lesson 4. Muscle physiology. Types of muscle. Skeletal muscle. Skeletal muscle contraction. Excitation-contraction coupling. Physiological control of muscle tension.

Lesson 5. Autonomic nervous system. Functional organization. Division of the autonomic nervous system: sympathetic, parasympathetic. Physiological actions of the ANS. Synapses, neurotransmitters, and receptors. Central control of the autonomic nervous system.

Physiology of Blood

Lesson 1. Blood composition and functions. Cells, their density and volume. Concept of hematocrit. Plasma: volume and composition. Serum. Physicochemical constants. Hematopoiesis. Functions of blood.

Lesson 2. Erythrocyte physiology. Erythrocyte

structure. Membrane and cytoskeleton proteins involved in specific functions. Functions of erythrocyte: respiratory function, role in acid-base balance. Glucose metabolism: pathways that maintain hemoglobin function, membrane integrity and, protect erythrocytes from oxidative agents. Erythropoiesis and its regulation. Erythrocyte destruction: destruction rate, mechanisms, and iron recycling.

Lesson 3. Blood groups. Erythrocyte antigens. The ABO system: chemical structure and genetic determination. Determination of ABO blood type. Clinical significance. The Rh system: chemical structure and genetic determination. Compatibility and incompatibility.

Lesson 4. Hemostasis. Platelets. Thrombopoiesis. Definition and phases of hemostasis. Platelet plug formation: activation, aggregation, and adhesion of platelets. Blood coagulation: intrinsic and extrinsic pathways. Regulation of coagulation, functions of thrombin. Clot removal. Regulation of fibrinolysis.

Physiology of the cardiovascular system

Lesson 1. Functional structure of the cardiovascular system. Distribution of blood in the system.

Arrangement of systemic circulation. Differences in the perfusion of different organs. Control of the cardiovascular system.

Lesson 2. Cardiac excitability. Generation of heartbeat and conduction system. Action potentials of cardiac cells. Characteristics of heartbeat propagation. Refractory period. Regulation of heart rate and heartbeat conduction. Basis of electrocardiography.

Lesson 3. Mechanical aspects of the heart. Contractile characteristics of cardiac cells. Excitation-contraction coupling. Mechanism of contraction of cardiac cells. Frank-Starling mechanism. Inotropic state. Regulation of cardiac contractility.

Lesson 4. Dynamic aspects of the heart. Cardiac cycle. Analysis of hemodynamic changes during the cardiac cycle. Cardiac output. Intrinsic and extrinsic regulation of cardiac output.

Lesson 5. Circulatory system. Arterial circulation. Relationship between flow, pressure and resistance. Characteristics of the venous circulation. Venous return. capillary circulation. Functional characteristics of capillary circulation. Capillary exchange processes: diffusion, filtration, and reabsorption. Lymphatic system and circulation.

Lesson 6. Blood pressure. Blood pressure variability. Blood pressure regulation mechanisms: nervous

regulation, humoral regulation, renal regulation.
Measurement of blood pressure.

Lesson 7. Regulation of blood flow. Tissue flow regulation mechanisms. Flow autoregulation. Systemic mechanisms of flow regulation. Features of circulation in different organs.

Physiology of the renal system

Lesson 1. Generalities. Enumeration of the kidney's functions. Functional structure of the kidney and urinary system. The nephron: parts of the nephron and types of nephrons. The juxtaglomerular apparatus.

Lesson 2. Renal circulation. Vascularisation of the kidneys. Basic processes of urine formation: filtration, reabsorption, and secretion. Renal handling of different substances: examples. Concept of clearance. Determination of renal plasma flow by PAH acid clearance.

Lesson 3. Glomerular filtration. Properties and structure of the filtration barrier. Composition of the filtrate. Factors on which the glomerular filtration rate depends: Starling equation. Situations in which the glomerular filtration rate is modified. Measurement of filtration by inulin clearance. Autoregulation of renal blood flow and glomerular filtration rate.

Lesson 4. Tubular secretion and reabsorption. Mechanisms of tubular reabsorption. Examples of both active and passive reabsorptions. Proximal tubule: permeability characteristics and transport of different substances. Permeability characteristics and transport mechanisms in the loop of Henle, distal tubule and collecting tubules. Composition of urine.

Lesson 5. Mechanisms of urine concentration and dilution. Maximum concentration capacity of urine in the human kidney. Variations in urine volume and osmolarity. Counter current multiplication mechanism. Role of urea in urine concentration. Role of vasa recta. Excretion of diluted urine. Free water clearance and osmolar clearance.

Lesson 6. Regulation of extracellular fluid volume and osmolarity. Water balance and its control by ADH and the thirst mechanism. Sodium balance and its control by the sympathetic nervous system, the renin-angiotensin system, and the atrial natriuretic peptide.

Lesson 7. Renal regulation of acid-base balance. Normal pH values. Sources of acid input into the body. Buffer systems of the organism. Renal reabsorption of bicarbonate and excretion of hydrogenions.

Lesson 8. Micturition. Filling of the urinary bladder. Micturition reflex.

Physiology of the respiratory system

Lesson 1. Introduction. Structure and function of the respiratory system. What respiration is and why it is necessary. Respiratory and non-respiratory functions of the respiratory system. Anatomy and functional structures of the respiratory system: conducting zone, respiratory zone, thoracic cage. The circulatory system.

Lesson 2. Respiratory Mechanisms and Ventilation. Pulmonary ventilation and spirometry. Measurement of lung volumes. Respiratory mechanisms. Thoracic wall and respiratory muscles. The pleura: pressures during the respiratory cycle. Elasticity of lung tissue. Surface tension: surfactant and its functions. Property of gases. Gas diffusion. Boyle's Law. Air composition: gas pressures and atmospheric pressures. The respiratory cycle. Ventilation-perfusion relationship. Airways and their resistance. Pulmonary ventilation vs. alveolar ventilation. Anatomical dead space.

Lesson 3. O₂ and CO₂ exchange. Gas diffusion or exchange: general concepts. Alveolar ventilation and blood flow relationship. Diffusion of respiratory gases. Gas laws: Dalton's, Henry's and Fick's laws. Medical issues. Emphysema.

Lesson 4. Gas transport. General aspects. CO₂ transport. Transport of O₂ dissolved in blood and bound to hemoglobin. Hemoglobin: structure and types. Hemoglobin saturation. Dissociation curve. External factors that modulate hemoglobin's affinity for O₂.

Lesson 5. Control of respiration. Voluntary and involuntary respiration. Basic elements of respiratory control. Integrating center and effectors. Sensors. Chemoreceptors and pulmonary and muscular mechanoreceptors.

Physiology of the digestive system

Lesson 1. Generalities. Functional organisation of the digestive tract. Structure of the wall of the gastrointestinal tract. Characteristics of the gastrointestinal smooth muscle. Intrinsic and extrinsic innervation of the digestive tract.

Lesson 2. Mastication, salivation, and swallowing. Mechanical characteristics of mastication. Reflex of mastication. Functions of saliva. Salivary glands. Components of saliva. Nervous control of salivary secretion. Phases of swallowing. Swallowing reflex.

Lesson 3. Gastric secretion and motility. Functions of gastric juice. Structure of the stomach glands.

Composition of gastric juice. Mucosal-gastric barrier. Regulation of gastric juice secretion: phases. Motor functions of the stomach. Gastric filling. Proximal and distal stomach motility. Gastric emptying: regulation. Motility in interdigestive periods.

Lesson 4. Exocrine pancreas. Functions of pancreatic juice. Structure of the pancreas. Composition of pancreatic juice. Regulation of pancreatic juice secretion: phases.

Lesson 5. Liver and biliary secretion. Functional structure of the liver. Functions of the bile. Composition of the bile. Bile acids: enterohepatic circulation. Bile pigments. Phospholipids. Cholesterol. Bile storage in the gallbladder. Control of the gallbladder emptying.

Lesson 6. Small intestine. Intestinal secretion: composition and regulation. Intestinal motility: types of movements and their control. Gastroileal reflex.

Lesson 7. Digestion and absorption. Digestion and absorption of carbohydrates. Digestion and absorption of lipids. Digestion and absorption of proteins. Absorption of water and electrolytes. Absorption of water-soluble and fat-soluble vitamins.

Lesson 8. Large intestine. Secretion and absorption in the colon. Intestinal bacteria. Composition of faeces. Types of movements in the colon. Regulation of motility. Defecation reflex.

Lesson 9. Control of solid intake. Centres of control of solid intake at the level of the central nervous system. Peripheral signals involved in the control of solid intake: gastrointestinal, pancreatic, and adipose tissue.

Physiology of the endocrine system and reproductive system

Lesson 1. Introduction to the endocrine system. Definition of the endocrine system. Concept of hormone. Types of hormones. Biosynthesis and hormone secretion. Blood transport. Negative and positive feedback loops in the regulation of the hormone secretion. Hormone receptors. Membrane receptors. Nuclear receptors. Mediators of hormone action (second messengers).

Lesson 2. Hypothalamo-neurohypophyseal hormones. The hypothalamus and its endocrine functions. Hypothalamic-pituitary axis. Portal system. Neurohypophyseal hormones. Structure, synthesis, and secretion of ADH (vasopressin) and oxytocin. Neurophysins. Physiological actions and regulation of

ADH. Physiological actions and regulation of oxytocin.

Lesson 3. Growth hormone and prolactin. Synthesis and secretion of hGH. Physiological actions of hGH. Insulin-like growth factors (IGF). Metabolic actions of hGH. Regulation of hGH secretion. Physiological actions of prolactin: regulation.

Lesson 4. Thyroid hormones. Structure. Biosynthesis: iodine metabolism. Secretion of thyroid hormones. Actions of TSH. Physiological actions of thyroid hormones. Iodine deficiency. Endemic goitre.

Lesson 5. Hormonal control of calcium (Ca²⁺) and phosphate (Pi) metabolism. Crucial roles of Ca²⁺ and Pi in cell physiology. The parathyroid gland. Parathyroid hormone (PTH). Actions and regulation of PTH. Calcitonin: physiological actions. Vitamin D: synthesis and metabolism. Physiological actions of 1,25-dihydroxyvitamin D₃; regulation of its production.

Lesson 6. Physiology of the endocrine pancreas. Regulation of blood glucose. Hormones of the pancreas. Insulin synthesis and secretion. Physiological actions of insulin: liver, skeletal muscle, adipose tissue, other actions. Control of insulin secretion. Glucagon. Physiological actions of glucagon. Regulation of glucagon secretion. Somatostatin. Major hormones involved in metabolic homeostasis: insulin, glucagon, adrenaline, and noradrenaline, hGH, and cortisol.

Lesson 7. Physiology of the adrenal glands. Adrenal cortex. Biosynthesis of adrenal steroids. Renin-angiotensin-aldosterone axis. Aldosterone actions. Cortisol regulation. Physiological pleiotropic actions of cortisol. Adrenal androgens. Adrenal medulla. Biosynthesis, storage, and secretion of catecholamines. Physiological actions of adrenal catecholamines.

Lesson 8. Physiology of the male reproductive system. Functional structure. Testosterone synthesis. Mechanism of action. Physiological actions of testosterone: genital tract, development of secondary sexual characteristics and effects on spermatogenesis. Hypothalamic-pituitary-testicular axis, and its regulation.

Lesson 9. Physiology of the female reproductive system. Functional structure. Ovarian hormones: oestrogen, progesterone. Menstrual cycle: cyclical variations in the ovaries, cyclical variations in the uterine endometrium. Hypothalamic-pituitary-ovarian axis. Puberty and menopause. Anovulatories.

Lesson 10. Pregnancy, childbirth, and lactation. Fertilisation, early embryogenesis and implantation and placentation. Placental endocrinology: pregnancy hormones. Childbirth. Prolactin and milk production.

Lesson 11. Sexual differentiation. Chromosomal or genetic sexual differentiation, gonadal differentiation, and genital differentiation. Alterations in sexual differentiation.

Physiology of the nervous system

Lesson 1. Functional organization of the nervous system. Nervous system function. Central and peripheral nervous system. Centers of the central nervous system: sensory, motor and association centers. General functions of the brain and spinal cord. The cerebral cortex. Limbic system: learning, memory, emotion.

Lesson 2. General principles of sensory systems. Functions of the sensory system. Stages of sensory information processing: transduction (sensory receptors, receptor potentials), coding, transmission, modulation, perception.

Lesson 3. The somatosensory system. Modalities / receptors: touch, proprioception, temperature, pain. Afferent nerves: peripheral and spinal nerves, dermatomes, conduction velocity. Ascending pathways: dorsal column system and spinothalamic or anterolateral system. somatosensory cortex.

Lesson 4. The visual system. Functional organization. Photoreceptors: cones and rods. Retinotopic representation of the visual field. Blind point. Central pathways of vision.

Lesson 5. The auditory system. Functional organization. External, middle and inner ear. cochlear mechanics. Tonotopy in the basilar membrane. Hair cells. Auditory pathway.

Lesson 6. The vestibular system. Functions. Functional organization of the vestibule. Hair cells. Vestibular pathway.

Lesson 7. Chemical systems: taste and smell. Taste: taste stimuli, receptors and taste buds. Taste transduction mechanisms, pathways. Smell: stimulus, olfactory receptors, olfactory transduction, pathways.

Lesson 8. Introduction to the physiology of the motor nervous system. Motor action. Sensory information for movement control. Hierarchical levels. Spinal cord: topographic organization. Motor cortex: areas. Brain stem. Muscle contraction: motor unit concept and asynchrony in motor unit recruitment. Muscle tone.

Lesson 9. Motor control by the spinal cord. Myotatic reflex or stretch reflex. Differences between reflex movement and voluntary movement and stages of movement planning.

Lesson 10. Voluntary movement: control of movement by the brain. Motor areas of the cerebral cortex. Activity of neurons in the primary motor cortex, supplementary motor area, and premotor cortex. General functions of the cerebellum. Function of the basal ganglia.

PRACTICAL LESSONS

The practices will be held on the days and times that will be indicated and will be as follows:

Practice 1. Measurement of the hematocrit value of blood.

Practice 2. Measurement of blood pressure.

Practice 3. Urine analysis. Response to water overload.

Practice 4. .

Practice 5. Neurological examination.

Practice questions will be included in the midterm and final exams.

EVALUATION CRITERIA

- There will be 3 mid-term exams. Each exam will consist of multiple-choice questions with 4 options (only one correct answer) and one short-answer question per topic covered. The number of multiple-choice items will be proportional to the number of class hours dedicated to each unit.
- Mid-terms are eliminatory and non-compensatory. The grade from one mid-term cannot be balanced by another. Additionally, the tests will contain questions related to the practical sessions.
- To pass the multiple-choice section (a 5/10), students must answer correctly at least 60 % of the items, discounting the score that could be obtained by chance.
- Mid-term grade formula:
$$(0.5 \times \text{multiple-choice score}) + (0.5 \times \text{average short-answer score})$$
- If either the multiple-choice score or the short-answer score is below 3/10, the overall grade for that mid-term will be capped at 4.5/10 (fail).

- Students who obtain at least 4.5 on a mid-term may improve their mark through continuous-assessment activities, subject to the instructor's discretion.
- The ordinary final exam will include both multiple-choice and short-answer questions.
- The extraordinary exam will consist exclusively of short-answer questions.

Passing the course

The grade of each passed partial will be kept for the final exams in June (1st call) and July (2nd call).

Students who have passed midterm exams (one or more) will not have to take that part of the subject in the final exams.

In the case of failing one or more partial exams or one or more parts of the ordinary or extraordinary exams, the grade that will appear on the record will be a maximum of 4.5 (failed).

The student who does not pass the entire course in the 2nd call must repeat the entire syllabus and retake the exam of the entire course during the following academic year.

Attitude to follow in the case of a voluntary or accidental violation of the exam rules

The voluntary or accidental infraction of the exam norms will prevent its valuation, so the offending student will take an oral exam of the subject to establish his / her knowledge. If intentionality in the deception is confirmed, it will be considered a very serious ethical misconduct, and the Services Inspection will be informed to take the disciplinary measures that it deems appropriate.

TUTORIALS

The faculty, both face-to-face and online, will personally attend the 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 an essential requirement to previously arrange it with the professor.

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