BSc MEDICAL RADIOLOGY TECHNIQUES FOR IMAGING AND RADIOTHERAPY

INTEGRATED COURSE: ANATOMY, HISTOLOGY AND HUMAN PHYSIOLOGY
SSD: BIOS-12/A (ex BIO/16)**,** BIOS-13/A (ex BIO/17), BIOS-06/A (ex BIO/09), MEDS-22/A (ex MED/36)
CFU: 8
RESPONSIBLE PROFESSOR: ANAS RASHID

Module: Human Anatomy and Radiological Anatomy
SSD: BIOS-12/A (ex BIO/16)
CFU: 4
Professor: Anas Rashid
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Module: Histology
SSD: BIOS-13/A (ex BIO/17)
CFU: 1
Professor: Edoardo Parrella
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Module: Human Physiology
SSD: BIOS-06/A (ex BIO/09),
CFU:2
Professor: Francesca Anastasi
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Module: Radiological Anatomy
SSD: MEDS-22/A (ex MED/36)
CFU: 1
Professor: Antonella Ciabattoni
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PREREQUISITES
Basic knowledge of physics, chemistry, biology and cytology.

LEARNING OBJECTIVES
Upon completion of this course, student will be able to:

- macroscopic organization of human body using the appropriate terminology;
- main cavities of body, and individual organs of various apparatuses and systems from a macroscopic, microscopic and topographic point of view;
- functions of various organs and systems of human body and mechanisms underlying these functions;
- principal tissues of human body and their functions;
- functional integration of various systems and their regulation in physiological conditions to maintain homeostasis.

The purpose of this course is to build upon students' understanding of the fundamental concepts and normal quantitative parameters of body functions, as well as their variations under different dynamic conditions. The course aims to develop the ability to comprehend the principles governing the functioning

of the human body. Cellular mechanisms and the integrated functions of major organs and systems will be analyzed with a focus on maintaining homeostasis in response to environmental changes.

Furthermore, the course seeks to provide students with the knowledge and skills required for a comprehensive understanding of the most significant tissues of the human body. Emphasis will be placed on the acquisition of proper scientific terminology and the development of interpretative and practical skills that graduates will later apply in the planning and management of professional activities.

Students will gain foundational knowledge of radiological anatomy and radiographic imaging. The course will introduce basic concepts of physics relevant to the processes underlying radiographic image formation. Standard radiographic projections will be reviewed, and students will learn to correlate normal anatomy and physiology with corresponding radiological images in both traditional and advanced imaging modalities.

LEARNING OUTCOMES

Knowledge and understanding

Upon completion of this course, student will be able to:

- Describe fundamental terminology and basic organization of human anatomical structures (e.g., locomotor system and cardio-splanchnology).
- Outline fundamental organization of neuroanatomical structures.
- Identify specific components within anatomical regions and explain their functional and physical interactions.
- Explain anatomical and functional organization of major organs, systems, and regulatory systems of human body.
- Interpret anatomical and physiological mechanisms and phenomena.
- Classify structures of various tissues that compose human body and describe histological organization of various human organs.
- Identify tissues and their constituent cells from both a morphological and functional perspective.
- Analyze bodily functions, including molecular and cellular mechanisms underlying them, and principal processes of integration, regulation, and homeostatic control.
- Explain principles underlying measurement of key physiological parameters (e.g., blood pressure, electrocardiogram, and respiratory parameters).
- Synthesize and correlate information across various topics in anatomy, histology, and physiology.

Applied knowledge and understanding

Upon completion of this course, student will be able to:

- Apply acquired knowledge of human anatomy to understand human physiology and pathophysiology, a fundamental requirement for professional practice in health sector. Students will also be able to use this knowledge for independent study and exploration of topics relevant to their future professional activities.
- Apply knowledge of histology to understand closely related branches of biology, including anatomy, cytology, and physiology.
- Demonstrate an understanding of cell physiology to explain mechanisms underlying maintenance of homeostasis.
- Integrate knowledge of anatomy and physiology to understand control systems regulating key processes such as nutrient absorption and excretion.
- Demonstrate adequate knowledge of radiological anatomy to correctly perform and interpret diagnostic imaging procedures using appropriate radiological techniques.
- Apply specific diagnostic protocols for correct execution of diagnostic tests.
- Implement quality control methodologies on diagnostic equipment to ensure accuracy and patient safety.

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- Engage in autonomous learning and deepening of subject matter, developing skills for lifelong professional development.
- Utilize knowledge acquired as a foundation for subsequent advanced courses in curriculum.
- Apply anatomical knowledge to perform radiographic projections targeted to specific anatomical structures.

Communication skills

Upon completion of this course, student will be able to:

- Demonstrate adequate knowledge of human anatomical structures and correctly use anatomical terminology to communicate effectively—verbally, non-verbally, and in writing—with patients of all ages and with other health professionals within the care process.
- Use precise scientific terminology to identify and describe, at microscopic level, different types of cells and tissues present in human body.
- Apply appropriate scientific terminology consistently across written and oral communication in academic and professional contexts.
- Explain physiological processes that occur in human body using correct scientific language.
- Identify and describe radiographic projections and anatomical structures visible in imaging studies, using proper scientific and technical terminology.

Problem solving skills

The student will be able to:

- Develop professional autonomy within a multidisciplinary approach to patient management. The knowledge acquired will enable the student to independently manage patient during diagnostic or therapeutic technical procedures, including data acquisition.
- Perform general assessments on topics covered during course.
- Conduct a basic evaluation of anatomical structures visible in diagnostic images, including ability to identify and correct any patient malpositioning.

INTEGRATED COURSE SYLLABUS

Module: HUMAN ANATOMY

LOCOMOTOR APPARATUS (12 hours): Axial skeleton: skull, vertebral column, vertebrae, pelvic girdle. Appendicular skeleton: shoulder girdle, arm bones, forearm and hand, thigh bones, leg and foot. Joints: classification and movements. Temporo-mandibular, sternoclavicular, shoulder, intervertebral joints, elbow joint, radioulnar joints, wrist and hand. Joints of the hip, knee, ankle. Muscular skeletal system. Axial muscles: head, neck, extrinsic muscles of the eye, tongue, pharynx, larynx, main muscles associated with the spine, diaphragm, muscles of the perineum and urogenital diaphragm. Appendicular muscles: shoulder girdle, arm, forearm and hand. Muscles of the thigh, leg and foot.

CARDIOVASCULAR SYSTEM (8 hours): Heart, coronary circulation, thoracic aorta, abdominal and their main branches. Willis polygon. Main arteries of the upper and lower limbs. Venous system: hollow veins and its major tributaries. Main veins of the upper limb, thorax, abdomen and lower limb. Portal circulation. Fetal circulation. General information on the lymphatic system.

SPLANCNOLOGY (8 hours). Microscopic and macroscopic anatomy of the digestive, respiratory, urinary, reproductive and endocrine tracts.

NEUROANATOMY (12 hours): Spinal cord: segments and internal organization: gray matter, ascending and descending tracts. Anatomy and pathways of spinal nerves, nerve plexuses and reflex arches. Brain stem (Medulla oblongata, Pons, Mesencephalon): internal and external structure. Cranial nerves: pathways and nuclei of origin and innervation. Diencephalon (Thalamus, Hypothalamus, Subthalamus, Epithalamus): internal and external structure. Thalamic and hypotalamic nuclei. Telencephalon: internal and external structure. Anatomical and functional organization of the cerebral cortex. Allocortex. Basal ganglia: anatomy and afferent and efferent pathways. Cerebellum: internal and external structure. Ventricle system. Meninges. Blood circulation of the brain and dural sinuses. Sensory system: spinothalamic tract, fascicolus

gracilis and cuneatus tracts, spinocerebellar tract. Conduction of pain. Visual, auditory, gustatory, olfactory and limbic system. Motor system: pyramidal and extrapyramidal tracts. Motor nuclei. Autonomic nervous system: sympathetic and parasympathetic system. Enteric nervous system.

Module: HISTOLOGY

PREPARATION OF TISSUES FOR HISTOLOGICAL ANALYSIS. Microscopy, preservation of biological structures, stainings.

EPITHELIAL TISSUE. General characteristics of epithelia, junctions, polarity of epithelial cells, surface specializations, basal lamina, classification of epithelia, endothelium, absorbent epithelium, pseudostratified epithelium, transitional epithelium, epidermis, glandular epithelia (exocrine and endocrine glands).

CONNECTIVE TISSUE. Histological organization: extracellular matrix (macromolecules of the ground substance, collagen and elastic fibers) and connective cells (fibroblasts, adipocytes, macrophages, plasma cells and mast cells). The different types of connective proper: loose and dense (irregular and regular). The white and brown adipose tissue. Supportive connective tissues: cartilage (cells and extracellular matrix, hyaline, elastic and fibrous cartilage, growth and repair) and bone (cells and extracellular matrix, compact and spongy bone, osteogenesis, growth and repair). Blood: plasma and serum, cells (red blood cells, neutrophils, eosinophils, basophils, monocytes and lymphocytes), platelets, hematopoiesis. Outline of the lymphatic system.

MUSCLE TISSUE. Skeletal muscle: organization of muscle fibers, myofibrils and myofilaments, sarcomere, sarcoplasmic reticulum, neuromuscular junction, contraction mechanism, regeneration. Cardiac muscle: structure of cardiomyocytes (intercalated discs, sarcoplasmic reticulum, myofilaments), Purkinje fibers, regeneration. Smooth muscle: structure of smooth muscle cells, contractile apparatus, regeneration.

NERVOUS TISSUE. The neuron. Myelinated and unmyelinated nerve fibers. General structure of the nerves. Synapses. Glial cells.

Module: HUMAN PHYSIOLOGY

Cell Membrane Physiology:

- Transport of ions and molecules across the cell membrane.
- Membrane potential and action potential.

Muscle Physiology:

- Excitation and contraction of skeletal muscle tissue.
- Neuromuscular transmission and excitation-contraction coupling.
- Motor unit

Nervous System Physiology:

- Sensory system: decoding and processing of sensory information.
- Motor system: general characteristics of motor system: involuntary, voluntary and automatic movements; spinal reflexes; brain stem control of movement: posture and balance. Cortical control of voluntary movements. Cerebellum: general characteristics, functions of cerebellum. Basal ganglia: functional role.
- Autonomic nervous system.
- Integrative functions of nervous system.

Cardiovascular Physiology:

Myocardial physiology: functional anatomy of the myocardium, action potentials of the myocardium, contraction of the heart muscle.

Cardiac cycle

- Nervous control of cardiac activity.
- General principles of hemodynamics.
- Regulation of circulation, blood pressure and blood flow.
- Cardiac output: principles of regulation of cardiac output.
- Heart tones.

Respiratory System:

- Pulmonary ventilation: respiratory mechanics, lung volumes and capacities. Respiratory tract
- Gaseous exchanges: diffusion of oxygen and carbon dioxide through the respiratory membrane.
- Transport of oxygen and carbon dioxide in the blood and body fluids.
- Regulation of breathing: general principles.
- Acid-base balance regulation: general principles.

Body fluids and kidney function:

- Functional anatomy of the kidney, function of the nephron. Glomerular filtration: general principles.
- Processing of glomerular filtrate: reabsorption and tubular secretion,
- Control of osmolarity and sodium concentration of the extracellular fluid: general principles.
- Renal regulation of blood volume: general principles

Endocrine system:

- General principles of endocrinology: nature of a hormone.
- General picture of the endocrine glands and their hormones.
- Principles of general functioning of hormones.

Module: RADIOLOGICAL ANATOMY

Course Objectives:

- Introduce students to basic principles of human anatomy as visualized through medical imaging.
- Provide foundational knowledge of radiological planes, terminology, and image interpretation.
- Explain principles of image formation in conventional radiography, CT, and MRI.
- Develop introductory skills in recognizing normal anatomical structures across different imaging modalities.

Programme:

- Introduction to Radiological Anatomy and Imaging Modalities
- Definition and scope of radiological anatomy
- Radiological terminology: planes, positions, and projections
- Image formation principles:
  - Conventional Radiography (X-ray): X-ray beam attenuation, radiographic densities (air, fat, water, bone, metal)
  - Computed Tomography (CT): cross-sectional imaging, Hounsfield units, advantages over X-ray
  - Magnetic Resonance Imaging (MRI): magnetic fields, proton alignment, signal intensity, soft tissue contrast
- Skeletal System
- Thorax, Abdomen, Pelvis
- Head and Neck
- Principles of radiological protection

COURSE STRUCTURE

- Human Anatomy is organized in 40 hours of lectures and theoretical / practical exercises. During lessons, explanation of human anatomy will be performed by projecting BRS Gross Anatomy. During exercises, students will be able to use anatomical models that reproduce organs and anatomical systems in a perfectly equipped exercise room.
- Histology is structured in 10 hours of lectures during which professor makes use of Power Point presentations and uses images of histological preparations obtained under an optical microscope and electronic and audiovisual media.
- Physiology is structured in 20 hours of lectures during which professor makes use of Power Point presentations.
- Radiological Anatomy consists of 10 hours of lectures during which professor makes use of Power Point presentations and presents radiological images.

At the end of each module, students will take a mock exam to familiarize themselves with final exam format (both written and oral) and identify areas for improvement.

GRADE DETERMINATION

Examination for Integrated Course of Anatomy, Histology, and Human Physiology consists of two parts: a written exam followed by an oral exam.

- Written exam is composed of multiple-choice questions. To be admitted to oral exam, students must achieve a minimum pass score of 18/30 on written component.
- A minimum pass score of 18/30 is also required on oral exam.
- Integrated Course is only considered passed after student successfully completes both parts.
- Upon completion of entire examination, student will receive a final assessment of "Suitable" or "Unsuitable" for passing Integrated Course. All content outlined in course syllabus is subject to assessment.
- Module: Radiological Anatomy: Final evaluation: written test + practical identification of structures on radiographs, CT, and MRI images.

For eligible students, the unit of measurement used is the grade out of thirty.

- Ineligible (exam not passed): important deficiencies and/or inaccuracies in knowledge and understanding of topics; limited capacity for analysis and synthesis, frequent generalizations.
- 18-20: just sufficient knowledge and understanding of topics with possible imperfections; ability to analyze synthesis and independent judgment sufficient.
- 21-23: knowledge and understanding of routine topics; correct analysis and synthesis skills with coherent logical argumentation.
- 24-26: good knowledge and understanding of topics; good analytical and synthesis skills with rigorously expressed arguments.
- 27-29: complete knowledge and understanding of topics; remarkable analytical and synthesis skills with good autonomy of judgment.
- 30-30L: excellent level of knowledge and understanding of topics. Remarkable capacity for analysis and synthesis and independent judgement. Arguments expressed in an original way.

OPTIONAL ACTIVITIES

Students will have opportunity to conduct theoretical/practical exercises and to attend seminars. Professors will provide constant support during and after lectures.

READING MATERIALS

- Halliday NL, Chung HM. BRS Gross Anatomy. 10th ed. North American Edition. Wolters Kluwer; 2021.
- Martini F, Timmons M, Tallitsch R. Human Anatomy. 9th ed. Pearson; 2020.
- Tortora GJ, Derrickson B. Principles of Anatomy and Physiology. 16th ed. Wiley; 2020.
- Martini FH, Nath JL. Anatomy & Physiology. 11th ed. Pearson; 2018.
- Mescher AL. Junqueira's Basic Histology: Text and Atlas. 16th ed. McGraw-Hill; 2021.
- Raff H, Coffin D. Berne & Levy Physiology. 7th ed. Elsevier; 2023.
- Sherwood L. Human Physiology: From Cells to Systems. 9th ed. Cengage Learning; 2016.
- Hall JE, Hall ME. Guyton and Hall Textbook of Medical Physiology. 14th ed. Elsevier; 2021.
- Hall EJ, Giaccia AJ. Radiobiology for the Radiologist. 7th ed. Lippincott Williams & Wilkins; 2018.
- Lampignano J, Kendrick LE. Bontrager's Handbook of Radiographic Positioning and Techniques. 9th ed. Elsevier; 2017.