functional architecture of the human body (msk/heart/vascular system) (MZ000006)

1. language

English

2. course contents

Coordinator: Prof. CRISTIAN RIPOLI

Year Course: I

Semester: 2nd semester

CFU/UFC: 12

Modules and lecturers:
- BONES AND MUSCLES ANATOMY (MZ000067) – 2,50 CFU - SSD BIO/16
  Prof. Vittoria Pagliarini
- ANATOMY PRACTICALS (MZ000068) – 0,50 CFU - SSD BIO/16
  Prof. Vittoria Pagliarini
- BONES AND MUSCLES HISTOLOGY AND EMBRIOLOGY (MZ000069) – 0,50 CFU - SSD BIO/17 Prof. Bianca Maria Scicchitano
- HISTOLOGY PRACTICALS (MZ000070) – 0,50 CFU - SSD BIO/17
  t.b.d.
- BONES AND MUSCLES PHYSIOLOGY (MZ000071) – 1,50 CFU - SSD BIO/09
  Prof. Roberto Piacentini
- PHYSIOLOGY PRACTICALS (MZ000072) – 0,50 CFU - SSD BIO/09
  Prof. Fabiola Paciello
- HEART ANATOMY (MZ000073) – 0,50 CFU - SSD BIO/16
  Prof. Vittoria Pagliarini
- ANATOMY PRACTICALS (MZ000074) – 0,50 CFU - SSD BIO/16
  Prof. Claudio Sette
- HEART HISTOLOGY AND EMBRIOLOGY (MZ000075) – 0,50 CFU - SSD BIO/17
  Prof. Bianca Maria Scicchitano
- HEART PHYSIOLOGY (MZ000076) – 1,50 CFU - SSD BIO/09
  Prof. Cristian Ripoli
- PHYSIOLOGY PRACTICALS (MZ000077) – 0,50 CFU - SSD BIO/09
  Prof. Marco Rinaudo
- VASCULAR ANATOMY (MZ000078) – 1 CFU - SSD BIO/16
  Prof. Claudio Sette
- VASCULAR HISTOLOGY AND EMBRIOLOGY (MZ000079) – 0,50 CFU - SSD BIO/17
  Prof. Bianca Maria Scicchitano

- VASCULAR PHYSIOLOGY (MZ000080) – 1 CFU - SSD BIO/09
  Prof. Cristian Ripoli

3. BIBLIOGRAPHY

ANATOMY:
Susan Standring: Gray's Anatomy, The Anatomical Basis of Clinical Practice, 41st Edition, Elsevier.
Frank H. Netter: Atlas of Human Anatomy, 7th Edition, Elsevier.

EMBRYOLOGY:
Keith L. Moore, T.V.N. Persaud, Mark G. Torchia: The Developing Human- Clinically Oriented Embryology, 11th Edition, Elsevier, 2019. See also: Gary C. Schoenwolf, Steven B. Bleyl, Philip R. Brauer, Philippa H. Francis West: Larsen's Human Embryology, 6th Edition, Churchill Livingstone, Elsevier, 2020.

HISTOLOGY:
Wojciech Pawlina: Histology- A Text and Atlas with correlated cell and molecular biology, Eighth Edition, Wolters Kluwer, 2019.

PHYSIOLOGY:
W. F. Boron and E. L. Boulpaep: Medical Physiology, 3rd Edition, Elsevier, 2017.
See also: Guyton and Hall: Textbook of Medical Physiology, 14th Edition, Elsevier, 2020.

4. LEARNING OBJECTIVES

The integrated course is designed to give students a comprehensive understanding of the musculoskeletal and cardiovascular (heart and vascular) systems. This is achieved through an integrated systemic approach that combines Anatomy, Embryology, Histology, and Physiology. Specifically, the Anatomy modules focus on the gross structure, microscopic anatomy, and functional correlations of the various organs. The Histology and Embryology modules discuss the development principles and detail the histological structures of various systems, linking them to cell and molecular biology. The Physiology modules explain the fundamental mechanisms that underpin system functioning, with an emphasis on their interactions.
Significant importance is placed on the clinical implications of these disciplines. Students are encouraged to use clear and appropriate language.
By the end of the course, students must demonstrate that they have achieved the following objectives:

Knowledge and understanding abilities – To acquire knowledge of the different levels of organization of human musculoskeletal and cardiovascular systems at macroscopic and microscopic levels. Demonstrate knowledge of cellular functions and physiological mechanisms for the implicated tissues and organs. Demonstrate an understanding of basic embryological mechanisms of musculoskeletal and cardiovascular system development.

Applied knowledge and understanding skills – To understand and appreciate the clinical relevance of the acquired knowledge about musculoskeletal and cardiovascular systems Anatomy, Histology, Embryology, and Physiology, concerning basic implications in pathology and diagnostic and therapeutic applications. Acquisition of practical skills in microscopic examination of musculoskeletal and cardiovascular tissue specimens. Awareness about methods used to better understand cells, tissues and organ functions.

Making judgments – The student must adequately integrate the knowledge and skills learned to develop autonomous abilities to identify the fundamental structures of musculoskeletal and cardiovascular systems and the associated physiological mechanisms relevant for the application in the medical field.

Communication skills – The student should be capable of communicating the acquired scientific knowledge and applied know-how in a clear and unambiguous way, using appropriate technical language.

Learning skills – Students should have acquired the competence to keep up-to-date and expand their knowledge by autonomously consulting reference textbooks, scientific literature, and

databases.

5. prerequisites

Students must have successfully completed and attended the Life of Cells, Tissues and Microbes and Gene Regulation and Cell Metabolism examinations to formally register for the exam session and gain a more comprehensive understanding of the course subject.

6. TEACHING METHODS

The course is organized into lectures and practical sessions covering the topics included in all the teaching modules to provide specialized elements of Anatomy, Histology/Embryology, and Physiology, concerning the human musculoskeletal and cardiovascular systems. All the lessons are supported by visual aids (slides, animated movies, etc.) that stimulate the interest of learners and help the teachers to explain the concepts easily. The teaching methods implement active learning activities, such as problem-based learning, self-learning, flipped classrooms, and practical activities. Required student learning includes individual work and activities in small groups. Students will have individual and personalized access to optical microscopes, anatomical and histological specimens, instruments for the evaluation of physiological parameters such as electromyographs, sphygmomanometers, stethoscopes, and electrocardiographs for practical training under teacher's supervision, and in subsequent self-learning sessions.

Knowledge and understanding: During theoretical lessons, the teachers will illustrate the main aspects of musculoskeletal and cardiovascular systems from the viewpoint of Anatomy, Histology, Embryology, and Physiology, underscoring the connections between these disciplines and the relevance of this knowledge for medicine and surgery.

Applying knowledge and understanding: During the frontal lessons and practical activities, teachers encourage an open dialogue and solicit student feedback. Students are invited to interact with the teacher to clarify specific points and achieve a deeper knowledge of the various topics. Written questions can be administered to the students during classes to facilitate learning and help them prepare for the exam.

Making judgments: During the Anatomy and Histology practicals, teachers begin with a pre-practical briefing and then discuss slides. In particular, during the practical training in microscopy, teachers attend to students individually for any clarification and stimulate their critical attitude in identifying the characteristics of the specimens and making a differential diagnosis. Anatomy practicals will focus on the structure and features of bones and muscles, including the heart, with emphasis on the vascularization of the organs. Physiology practicals emphasize measuring heart rate, electrical activity of heart and skeletal muscles, function of heart valves, and blood pressure with a range of medical instruments. Students engage in group discussions to analyze this data, formulating hypotheses about physiological processes and predicting the outcomes of experimental adjustments. These activities reinforce their theoretical knowledge and advance their analytical and problem-solving abilities.

Communication skills: During lessons and practicals, students are stimulated to ask and answer questions. If necessary, teachers suggest the appropriate terminology and the best way to give definitions and express concepts and data. The development of communication skills is promoted by working in small groups.

Learning skills: While theoretical lessons are focused on the fundamental aspects of the course contents, the students are expected to develop this knowledge by in-depth studying suggested textbooks and consulting additional references, such as interactive iconography or animated movies, available online. At any phase of their learning process, the students may request the teacher's clarification of specific aspects or additional references to expand their basic knowledge.

7. OTHER INFORMATIONS

The teachers can meet students individually upon request (by e-mail). To arrange an appointment you can contact the Instructors by email:

Prof. Claudio Sette claudio.sette@unicatt.it
Prof. Cristian Ripoli cristian.ripoli@unicatt.it
Prof. Vittoria Pagliarini vittoria.pagliarini@unicatt.it
Prof. Bianca Maria Scicchitano biancamaria.scicchitano@unicatt.it
Prof. Roberto Piacentini roberto.piacentini@unicatt.it
Prof. Fabiola Paciello fabiola.paciello@unicatt.it
Prof. Marco Rinaudo marco.rinaudo@unicatt.it

According to regulation, at least 65% of class attendance is required for direct admission to the final exam. Failure to fulfill this requirement, or any student's violations in the registration of attendance, will implicate further obligations or restrictions to access exam sessions.

DO NOT refer to Instructors for seeking technical assistance on class attendance or exam registration as they could not help with these issues, which would rather be checked with the administrative offices.

During the exams, any portable electronic devices, including mobile phones, must be switched off and put over the desk inside an envelope given by the Course Coordinator. The Course Coordinator may permit individuals to use certain devices in specific authorized cases. Violations will be referred to the Disciplinary Committee.

Any student found by the Instructors to be cheating will receive a failing grade for the exam or other graded work and will be reported to the MD Course's President. The Instructors may, at their discretion, decide to give a failing grade for the course in severe cases of academic dishonesty.

8. METHODS FOR VERIFYING LEARNING AND FOR EVALUATION

The exam comprises a written examination based on a multiple-choice test regarding all modules; for each question, a single correct answer is possible. To pass the written test, the student has to answer at least 60% of the questions in each discipline (i.e., Anatomy, Histology/Embryology and Physiology) correctly. Each correct answer corresponds to a score of 1, and a wrong/no answer corresponds to a score of 0. The system calculates the scores automatically.
In case of controversial issues, students may be called into a brief oral interview, aimed at validating the results of the multiple-choice questionnaire. The overall and final exam scores will be calculated using a weighted average of the partial scores obtained for the various integrated modules (Anatomy, Histology/Embryology and Physiology), considering the credits assigned to each discipline. The score obtained in the written test will be initially calculated for each of the disciplines for which the threshold was passed, ranging from 18 to 30/30 (or 30 cum laude). The highest grade is assigned to faultless tests.

Knowledge and understanding: A multiple-choice questionnaire will allow for the verification of the acquired knowledge about skeletal and muscular systems, from the various viewpoints of macroscopic anatomy, histology/embryology, and physiology.

Applying knowledge and understanding: Based on exemplified clinical cases, some of the questions in the written test will verify students' understanding of the relevance of the acquired theoretical knowledge in applied medicine and surgery. Moreover, a subset of Histology questions is aimed at assessing the acquired skills in the analysis of microscopic images of tissue specimens representative of skeletal and muscular systems.

Making judgments: For some of the questions in the written test, the students must identify the most appropriate and informative proposed answer.

Communication skills: The questions in the test will assess students' knowledge and understanding of the currently applied technical language in various disciplines.

Learning skills: Both the multiple-choice questionnaire and the analysis of histological specimens will allow the students to demonstrate the acquired knowledge, ranging from fundamental information to specific details, revealing in-depth learning skills.

9. program

SKELETAL - MUSCULAR SYSTEM

ANATOMY: Anatomical nomenclature: planes, directions and relationship, movements. Functional anatomy of the musculoskeletal system, general system anatomy. Introduction to osteology: definitions, vocabulary, classification and macroscopic structure of bones, bone sexual dimorphism. Introduction to arthrology: definitions, vocabulary, classification and macroscopic structure of joints. Systemic anatomy of the axial skeleton: skull bones and joints; spine: general structure, vertebrae, vertebral defects and spine malformations, intrinsic and extrinsic vertebral joints, thorax bones and joints. Systemic anatomy of the appendicular skeleton: bones and joints of the shoulder and pelvic girdles, bones and joints of the upper and the lower limbs. Introduction to myology: definitions, vocabulary, classifications and macroscopic structure, blood supplies and innervation of muscles; accessory organs of skeletal muscles (tendons, aponeurosis, bursae). Systemic anatomy of axial muscles: cranial and cervical muscles and aponeurosis, spinal and thorax muscles and aponeurosis. Systemic anatomy of appendicular muscles, upper limb muscles and aponeurosis, the axillary cavity, lower limb muscles and aponeurosis, the femoral triangle, the popliteal cavity; clinical correlates: congenital and injury-related muscle disorders. Practical training: anatomy lab practicals on human bone and muscle models; identification of anatomical structures.

EMBRYOLOGY: The Axial Skeleton, Skull, Vertebrae and the Vertebral Column, Ribs and Sternum. Developmental skeletal defects. Muscular System: Striated Skeletal Musculature. Innervation of Axial Skeletal Muscles. Skeletal Muscle and Tendons. Regulation of Muscle Development. Head Musculature. Limb Growth and Development. Limb Musculature.

HISTOLOGY: Cartilage: Overview of Cartilage, Hyaline Cartilage, Elastic Cartilage, Fibrocartilage. Chondrogenesis and Cartilage Growth. Repair of Hyaline Cartilage. Joints. Ligaments. Clinical correlations: cartilage diseases and degeneration. Bone: Overview of Bone: Bones and Bone Tissue. General Structure of Bones. Bone cells: Osteoprogenitor Cells, Osteoblasts, Osteocytes, Osteoclasts. Bone Formation. Intramembranous Ossification. Endochondral Ossification. Development of the Osteonal (Haversian) System. Bone Mineralization and Matrix Vesicles. Regulation of bone growth and bone remodeling. Nutritional factors in bone formation. Clinical correlates: Osteoporosis and other bone diseases. Muscle Tissue: Overview and classification of muscles. Skeletal Muscle. Myofibrils and myofilaments. The contraction cycle. Motor innervation. Sensory innervation. Development, repair, healing and renewal. Smooth Muscle. Structure and functional aspects. Muscle metabolism and ischemia. Clinical Correlates: Muscular Dystrophies. Myasthenia gravis. Practical training: Use of light microscope to understand the microanatomy and the differentiated cellular features in cartilage, bone, skeletal and smooth muscle. In case of inability to carry out practical training with a microscope (e.g. due to exceptional circumstances or restrictions), online training sessions will be organized for the analysis of histological images.

PHYSIOLOGY: Skeletal muscles: molecular aspects of muscle contraction, neuromuscular junction and neuromuscular signals, electro-mechanical coupling, mechanical events, isometric and isotonic contraction, tension, length, velocity relations, passive properties, motor units, contraction energy, fatigue, muscle energy metabolism. Smooth muscle and functional differences in comparison with skeletal muscle. Muscles and skeletal structures, interactions: biological joints, operative ranges, functional interactions among muscle-tendon complex, joint elements, and ligaments, joints as muscle-tendon integrators, joint mechanical impedance: its control, functional

and clinical implications, the passive and active role of ligaments. Controls: Fundamentals about adaptive controls in the skeletal system: nerve, muscle cartilage, and bone functional relations: clinical implications. Practical training: muscle physiology simulator, electromyography (EMG).

HEART

ANATOMY: Mediastinum: limits, division in the superior and inferior mediastinum, the topography of visceral structures. Overview of the cardiovascular system, systemic and pulmonary circulations, and fetal circulation. Heart: topography, position, and relations within the thoracic cavity, wall structure, fibrous skeleton, external and internal anatomy: chambers, valves, conducting system, coronary vessels, microscopic anatomy of the heart. Pericardium and pericardial sinuses, a brief introduction to congenital anatomical anomalies of the heart. Practicals: Introduction to medical examination and imaging of the vascular system, examination of heart models; radiographic anatomy of the heart.

EMBRYOLOGY: Establishment and patterning of the primary heat field. Progenitor heart cells. Secondary heart field. Formation and position of the heart tube. Formation of the cardiac loop. Molecular regulation of cardiac development. Development of the sinus venosus. Formation of the cardiac septa.

HISTOLOGY: Cardiac muscle. Structure of the heart muscle. Differentiation, renovation, damage, and repair. Intrinsic regulation of heart rate. Systemic regulation of the heart function. Practical training: Use a light microscope to understand the structure of cardiac muscle and correlate structure and function.

PHYSIOLOGY: Rhythmical excitation of the heart: the cardiac action potential. Specialized conductive system of the heart. Control of excitation and conduction in the heart. Characteristics of the normal electrocardiogram. Electrocardiographic leads. Principles of vectorial analysis of electrocardiograms. The cardiac muscle. The cardiac cycle. Preload and afterload. Stroke volume and cardiac output. Frank-Starling mechanism. Heart pump and artery elasticity. Cardiac work. Contractility modulation. Coronary circulation. Practicals: Electrocardiographic recording, auscultation of heart sounds.

VASCULAR SYSTEM

ANATOMY: A basic introduction to Pulmonary circulation, Systemic circulation, and the Lymphatic system. Blood vessels: structure and function. Arteries. Arterioles. Capillaries. Venules. Veins. Anastomoses. Vessels of the systemic circulation. Arterial System: aorta's origin, distribution, and main branches. Ascending aorta and its branches. Arch of the aorta: arteries of head and neck- arteries of the upper limb. Descending aorta: thoracic aorta; abdominal aorta and arteries of the lower limb. Venous system. Superior vena cava and its tributaries: veins of head, thorax, and upper limb. Inferior vena cava and its tributaries: veins of abdomen, pelvis and lower limb. Practicals: Microscopic examination of the structure of the aorta, vena cava, and other main vessels. Introduction to medical examination and imaging of the vascular system.

EMBRYOLOGY: Vasculogenesis and angiogenesis. Formation of primitive blood vessels associated with endocardial tube. Development of lymphatic system. Development of thymus, spleen and lymph nodes. Angiomas.

HISTOLOGY: Layers of the vascular wall. Vascular endothelium. Large, medium and small arteries. Classification and functional aspects of capillaries. Large and small veins. Lymphatic vessels. Lymphatic nodules. Cells of the reticular meshwork. The architecture of thymus, spleen, and lymph nodes. Atherosclerosis. Hypertension. Ischemic heart disease. Practical training: By studying histological sections of blood vessels, thymus, spleen and lymph nodes, students learn to recognize and analyze the different tissue and organ components.

PHYSIOLOGY: Hemodynamic premises. Arteries and veins. Microcirculation. Microcirculation regulation. Special circulation. Coagulation. Practicals: Measurement of blood pressure.