FUNCTIONAL ARCHITECTURE OF THE HUMAN BODY (MSK/HEART/VASCULAR SYSTEM) (A001943)

1. lingua insegnamento/language

Inglese.

2. contenuti/course contents

Coordinatore/Coordinator: Prof. SCICCHITANO BIANCA MARIA
Anno di corso/Year Course: 2025/2026
Semestre/Semester: Semestrale
CFU/UFC: 12
Moduli e docenti incaricati /Modules and lecturers:
- BONES AND MUSCLES ANATOMY (A002024) - 2.5 cfu - ssd BIO/16
Prof. Vittoria Pagliarini, Piergiorgio La Rosa
- BONES AND MUSCLES HYSTOLOGY AND EMBRYOLOGY (A002032) - 0.5 cfu - ssd BIO/17
Prof. Bianca Maria Scicchitano
- BONES AND MUSCLES PHYSIOLOGY (A002038) - 1.5 cfu - ssd BIO/09
Prof. Roberto Piacentini
- HEART ANATOMY (A002040) - 0.5 cfu - ssd BIO/16
Prof. Claudio Sette
- HEART HYSTOLOGY AND EMBRYOLOGY (A002044) - 0.5 cfu - ssd BIO/17
Prof. Bianca Maria Scicchitano
- HEART PHYSIOLOGY (A002046) - 1.5 cfu - ssd BIO/09
Prof. Guido Maria Filippi
- HYSTOLOGY PRACTICALS (A002037) - 0.5 cfu - ssd BIO/17
Prof. Luigi Balasco, Luigi Balasco
- PHYSIOLOGY PRACTICALS (A002039) - 0.5 cfu - ssd BIO/09
Prof. Giuseppe Aceto, Giuseppe Aceto
- PHYSIOLOGY PRACTICALS (A002048) - 0.5 cfu - ssd BIO/09
Prof. Walter Toscanelli
- VASCULAR ANATOMY (A002050) - 1 cfu - ssd BIO/16
Prof. Claudio Sette, Piergiorgio La Rosa
- VASCULAR HYSTOLOGY AND EMBRYOLOGY (A002052) - 0.5 cfu - ssd BIO/17
Prof. Bianca Maria Scicchitano
- VASCULAR PHYSIOLOGY (A002054) - 1 cfu - ssd BIO/09
Prof. Guido Maria Filippi

(Si raccomanda di <u>non modificare</u> i nominativi dei docenti indicati in questo form, che risultano i titolari dei conferimenti per l'a.a. 2025/2026. Eventuali variazioni intervenute in data posteriore alla delibera del Consiglio di Facoltà sui conferimenti dovranno essere comunicate al Servizio Personale Docente - Roma, per gli adempimenti di competenza.)

3. testi di riferimento/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. Anastasi G. Human Anatomy; Edi. Ermes For clinical correlates, see also: Keith L. Moore, Arthur F. Dalley and Anne M.R. Agur: Clinically Oriented Anatomy, 6th Edition: Hardcover Edition, Lippincott Williams and Wilkins.
EMBRYOLOGY: Keith L. Moore, T.V.N. Persaud, Mark G. Torchia: The Developing Human-Clinically Oriented Embryology, 11th Edition, Elsevier, 2019. Gary C. Schoenwolf, Steven B. Bleyl, Philip R. Brauer, Philippa H. Francis West: Larsen's Human Embryology, 6th Edition, Churchill Livingstone, Elsevier, 2020. **HISTOLOGY:** V. De Felice, B.M. Scicchitano, G. Dobrowolny, G. Ricci, M.T. Viscomi, Foundamentals of Histology, Structure and Function of Human Body Tissues and Systems, 2025, I Edition. Edizioni Scientifiche Falco. See also: 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. obiettivi formativi/LEARNING OBJECTIVES

The integrated course is designed to give students a comprehensive understanding of the Musculo-Skeletal and Cardio-Vascular (heart and vessels) 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 principles of development 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 furthermore guided to the acquisition of accurate scientific terminology.

In detail, by the end of the course, students must demonstrate having accomplished the following objectives:

Knowledge and understanding abilities – To acquire knowledge of the different levels of organization of the human musculoskeletal and cardiovascular systems, at macroscopic and microscopic levels. Acquire knowledge of cellular functions and physiological mechanisms for the implicated tissues and organs. Understand 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 the Anatomy, Histology, Embryology, and Physiology of musculoskeletal and cardiovascular systems, 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 will integrate the acquired knowledge and skills 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 learn how to keep up-to-date and expand their knowledge by autonomously consulting reference textbooks, scientific literature, and databases.

5. prerequisiti/prerequisites

In order to achieve a better understanding of the topics of this course, and to register for the exam session, Students should have passed the exam of Life of Cells, Tissues and Microbes.

6. metodi didattici/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 anatomical models, optical microscopes, and histological specimens, instruments for the evaluation of physiological parameters such as electromyographs, sphygmomanometers, stethoscopes, and electrocardiographs for practical training under the 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 to prepare for the exam.

Making judgments: During the Anatomy and Histology practicals, teachers begin with a content briefing and then discuss relevant specimen slides and anatomical models. 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. Physiology practicals emphasize measuring heart rate, electrical activity of the 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. altre informazioni/OTHER INFORMATION

The teachers can meet students individually upon request (by e-mail).

According to regulations, at least 65% of class attendance is required for direct admission to the final exam. Failure to fulfil this requirement, or any student's violations in the registration of attendance, will incur further obligations or restrictions to access exam sessions. Do not refer to the Instructors for seeking technical assistance on class attendance or exam registration, as they

cannot 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.

Students found by the Instructors to be cheating during an exam will receive a failing grade and will be reported to the Chairman of the MD program.

8. modalità di verifica dell'apprendimento/METHODS FOR VERIFYING LEARNING AND FOR EVALUATION

Exam Structure and Requirements:
The exam consists of two separate parts, each assessing the student's knowledge of:
- The Musculoskeletal System
- The Cardiovascular System

Passing Criteria:
To pass the exam, students must achieve a minimum score of 18/30 in each part.
The final grade (ranging from 18 to 30/30 with honors) will be calculated as the average of the two parts, each contributing equally.

Written Test: Multiple-Choice Questionnaire (MCQ):
Both parts will be assessed through an MCQ test. The questionnaire contains at least 70 questions covering:
- Anatomy
- Histology/Embryology
- Physiology

Each question has only one correct answer.

Discipline-Specific Passing Requirements:
To pass, students must answer at least 51% of the questions correctly in each subject (Anatomy, Histology/Embryology, and Physiology).To achieve the highest possible score, students must correctly answer over 97% of the questions.

Histology/Embryology Assessment:
Histology skills will also be evaluated through a mandatory practical test using a microscope, involving analysis of specimens related to the Musculoskeletal System and Cardiovascular System.
This practical test will be scheduled before the first exam date, at the end of the Histology practical course.
The practical test accounts for one-third of the final Histology/Embryology score, which is then combined with the MCQ results.
If the practical test result is unsatisfactory, it can be retaken before a subsequent exam date.

Final Grade Calculation
Upon passing the MCQ, a final grade will be calculated as a weighted average (based on the respective CFUs) of the results in Anatomy, Histology/Embryology, and Physiology.

Partial Pass Validity
Suppose a student passes only one part (either the Musculoskeletal System or Cardiovascular System), the grade for that part will be held and remain valid for the following exam sessions:
Until the extraordinary Christmas session for exams passed during the Summer or Fall sessions.
Until the Summer session for exams passed during the Winter session.

Knowledge and understanding: A multiple-choice questionnaire will allow verification of the acquired knowledge about the Musculoskeletal System and Cardiovascular System, in the integrated fields 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 are required to select the most appropriate and informative answer among the proposed acceptable ones. Questions exemplifying clinical cases will request students' judgments about the most relevant theoretical knowledge to answer the question.

Communication skills: The questions in the multiple-choice questionnaire will assess students' acquaintance with the currently applied technical language in various disciplines. The discussion of histological specimens during the practical test will furthermore assess the communication skills of the students.

Learning skills: Students' preparation for the exam will involve referring to complementary textbooks for the different integrated disciplines. The students will be guided to identify fundamental information, to be integrated with relevant details, and updated knowledge provided during the lessons and the practical sessions.

9. programma esteso/program

MUSCULO-SKELETAL 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 bones; identification of anatomical structures, main landmarks and movements on interactive anatomical modeling software.
EMBRYOLOGY: Cartilage development, Bone Formation. Intramembranous Ossification. Endochondral Ossification. Development of the Osteonal (Haversian) System. Bone Mineralization and Matrix Vesicles. Regulation of bone growth and bone remodelling. Clinical correlates: Osteoporosis and other bone diseases. The Axial Skeleton, Skull, Vertebrae and the Vertebral Column, Ribs and Sternum. Developmental skeletal defects. Muscular System: Striated Skeletal Musculature. Muscles. Regulation of Muscle Development.
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. 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.
Practical training: Heart dissection; introduction to medical examination and imaging of the vascular system, 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.
Practical training:: 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.
Practical training: 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.
Practical training: Measurement of blood pressure.