ORGANIC AND FUNCTIONAL SYSTEMS I: BONES AND MUSCLES (ML000030)

1. language

English

2. course contents

Coordinator: Prof. TAMAGNONE LUCA

Academic Year: 2022/2023

Year Course: 1st year

Semester: 2nd semester

CFU/UFC: 6

Moduli e docenti incaricati /Modules and lecturers:
- ANATOMY (ML000031) - 2.34 cfu - ssd BIO/16
Prof. Camilla Bernardini, Vittoria Pagliarini
- ANATOMY PRACTICALS (ML000032) - 0.66 cfu - ssd BIO/16
Prof. Camilla Bernardini, Chiara Naro
- HISTOLOGY AND EMBRIOLOGY (ML000035) - 0.7 cfu - ssd BIO/17
Prof. Luca Tamagnone, Bianca Maria Scicchitano
- HISTOLOGY PRACTICALS (ML000036) - 0.3 cfu - ssd BIO/17
Prof. Bianca Maria Scicchitano
- PHYSIOLOGY (ML000033) - 1.7 cfu - ssd BIO/09
Prof. Guido Maria Filippi
- PHYSIOLOGY PRACTICALS (ML000034) - 0.3 cfu - ssd BIO/09
Prof. Fabiola Paciello

3. bibliography

Anatomy:

Susan Standring: Gray's anatomy, The Anatomical Basis of Clinical Practice, 41st edition, Elsevier.

Frank H. Netter: Atlas of Human Anatomy, Elsevier, 2010

Histology:

Wojciech Pawlina: Histology- A Text and Atlas with Correlated Cell and Molecular Biology, 8th Edition, Wolters Kluwer, 2019

Embryology:

Keith L. Moore, T.V.N. Persaud, Mark G. Torchia: The Developing Human-Clinically Oriented Embryology, 11th Edition, Elsevier, 2019.

Physiology:

Walter F. Boron and Emile L. Boulpaep: Medical Physiology: A Cellular and Molecular Approach. Elsevier Health Sciences, 2012.

4. learning objectives

The whole course is aimed at giving the student a sound understanding of the structure, function, biology, and development of the musculoskeletal system, through a systemic approach integrating anatomy, embryology, histology, and physiology. The specific aims of single modules are as follows. The Anatomy module aims at providing a comprehensive knowledge on the gross structures of bones, joints, and skeletal muscles, with insights into radiological anatomy and appropriate clinical correlates. Students will be introduced to the localization of anatomical structures, the identification of main landmarks of the skeleton, and to the description of related movements, under physiological conditions. Hints on congenital anatomical variants and traumatology will be also provided. The Histology and Embryology modules aim to provide principles of development and illustrate the microscopic structure of skeletal tissues cartilage and bone, as well as of skeletal and smooth muscles, and establish clinical correlates. Students will have the opportunity to observe histological preparations under the microscope in order to acquire knowledge of normal histologic appearance, essential to recognize abnormal structures. The Physiology module aims to provide the students a broad understanding of the functional aspects of the skeleton, of skeletal muscles and smooth muscles, addressing biomechanics, electro-physiologic features, adaptive mechanisms, energy metabolism and molecular signaling.

At the end of the integrated course the student must demonstrate that he has accomplished the following objectives:

- *Knowledge and understanding abilities – To have acquired the knowledge of the different levels of organization of human skeletal and muscular systems, at macroscopic and microscopic levels. Demonstrate the knowledge of cellular functions and physiological mechanisms for the implicated tissues and organs. Demonstrate the knowledge of basic embryological mechanisms of skeletal and muscular system development.*

- *Applied knowledge and understanding skills – To understand and appreciate the clinical relevance of the acquired knowledge about skeletal and muscular systems anatomy, histology, embryology and physiology, with reference to basic implications in pathology, as well as diagnostic and therapeutic applications. Acquisition of practical skills in microscopic examination of skeletal and muscular tissue specimens. Awareness about methods used to acquire a better understanding of cells, tissues and organ functions.*

- *Personal judgement – The student must properly integrate the knowledge and skills learned to develop autonomous abilities to identify the fundamental structures of skeletal and muscular 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 unambiguously way, using an appropriate technical language.*

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

5. PREREQUISITES

In order to better understand the topics of the course and to formally register for the exam session, students must have attended and passed the exam of Biomedical Sciences I.

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 skeletal system and the associated muscles. The teaching methods implement active learning activities, such as problem-based learning, self-learning, and practical activities. Required student's learning includes individual work and activities in small groups. Students will have individual and personalized access to optical microscopes and histological specimens for practical training under teacher's supervision, and in subsequent self-learning sessions. In case of inability to carry out practical training with a microscope (e.g. due to Covid-19 prevention measures), online training sessions will be organized for the analysis of histological images.

Knowledge and understanding: During theoretical lessons, the teachers will illustrate the main aspects of Skeletal and Muscular 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 theoretical lessons (and practical activities) the students are stimulated to actively interact with the teacher, by asking questions aimed at clarification of specific points but also at expanding knowledge beyond the essential contents, and in perspective to its application for clinical medicine. Students may furthermore be challenged during classes with anonymous trial tests or problem solving questions, for training in preparation to the exam. During practical training sessions, the students will be confronted with methods of analysis relevant for diagnostic application, such as: morphological recognition of human skeletal structures, examination of histological specimens by optic microscopy, electromyography (EMG), etc.

Making judgements: During the practical training, students will be encouraged to ask questions and challenged to use simple analytical methods to recognize differences relevant in clinical perspective. For instance, in the microscopic analysis of histological sections, students will be stimulated to identify the most important elements in the specimen and underscore uncommon findings deserving further study.

Communication skills: Students are stimulated to ask questions and actively interact with the teacher during lessons and practical training sessions. Whenever needed, the teacher will correct and suggest the appropriate technical language to clearly express scientific concepts and data, in order to promote the acquisition of qualifying communication skills.

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 for example interactive iconography or animated movies, available online. At any phase of their learning process, the students may request to the teachers clarification of specific aspects or additional references for expanding basic knowledge.

7. other informations

The teachers are available to individually meet students upon request.

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 give individual permission to use certain devices in specific authorized cases. Violations will be referred to the Disciplinary Committee.

8. methods for verifying learning and for evaluation

The exam is composed by a written examination based on a multiple-choice test regarding all modules; for each question, a single correct answer is possible. In order to pass the written test, the student has to answer correctly to at least 60% of the questions of each discipline (i.e. Anatomy, Physiology and Histology/Embryology). Should the student succeed in two out of three sections of the exam, partial results will be kept valid until the end of the subsequent session of exams. 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. 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 score of the exam will be calculated by weighted average of the partial scores obtained for the various integrated modules (Anatomy, Histology/Embryology, and Physiology), taking in account the credits assigned to each discipline. The score will be rounded up to the nearest integer, in a range between 18 and 30 with honors (cum laude).

- *Knowledge and understanding: A multiple-choice questionnaire (40-50 questions) will allow verifying the acquired knowledge about skeletal and muscular systems, under the various viewpoints of macroscopic Anatomy, Histology/Embryology, and Physiology. An additional oral exam is aimed at assessing the acquired practical skills in microscopic examination of tissue specimens representative of these systems.*
- *Applying knowledge and understanding: Some of the questions in the written test, based on exemplified clinical cases, will verify students' understanding about the relevance of the acquired theoretical knowledge in applied medicine and surgery. Moreover, a brief oral interview is aimed at assessing the acquired practical skills in microscopic examination of tissue specimens representative of skeletal and muscular systems. In the description of histological structures and features, the students are expected to use appropriate technical language.*
- *Making judgements: During the practical test based on microscopic examination of histological sections, it will also be assessed the critical attitude of the student to identify the most important elements to be described and underscore uncommon findings, in the specimen under analysis.*
- *Communication skills: During the oral interview, it will be assessed the capacity to use an appropriate technical language in the description of tissues and organs of muscle-skeletal systems.*
- *Learning skills: Both the multiple-choiche 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 bones; identification of anatomical structures, main landmarks and movements on interactive anatomical modeling software.

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 Covid-19 prevention measures), 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, passive and active role of ligaments. Controls: Fundamentals about adaptive controls in skeletal system: nerve, muscle cartilage and bone functional relations: clinical implications. Practical training: muscle physiology simulator, electromyography (EMG).