MORPHOLOGICAL AND FUNCTIONAL SCIENCES (A000209)

1. language

Italian.

2. course contents

Coordinator: Prof. GRASSI CLAUDIO

Academic Year: 2022/2023

Year Course: 1st year

Semester: 1st Semester

UFC: 8

Modules and lecturers:
- FUNCTIONAL ANATOMY (A000232) - 2 ufc - ssd BIO/16
Prof. Claudio Sette
- MORPHOFUNCTIONAL MEASURES and NEUROPHYSIOLOGY (A000230) - 4 ufc - ssd BIO/09
Prof. Claudio Grassi
- ULTRASTRUCTURAL IMAGING TECHNIQUES (A000231) - 2 ufc - ssd FIS/07
Prof. Marco De Spirito

3. bibliography

Morphofunctional measures and Neurophysiology*: Fisiologia Medica, vol. 1 – a cura di F. Conti – Ed. EDI-ERMES*

Ultrastructural Imaging Techniques*: Bioimaging – D. Chandler and R. Roberson – Jones & Bartlett Publishers ISBN: 128406316X*

Functional Anatomy*: Anatomia Umana Fondamenti – Barbatelli et al. – Ed. EDI-ERMES, or Anatomia Umana – Martini – Edi-SES; Atlante di Istologia – Filippini, Musarò, Ziparo – Ed. Piccin*

4. learning objectives

The course aims to give the students sound understanding of morphological and functional organization of human body by integrating information on morphology, ultrastructure and function of organs and systems.
Specifically, students are expected to acquire:

Knowledge and understanding –*The student should be able to know and understand the molecular and cellular mechanisms underlying the functions of nervous system, the main methodologies used for ultrastructural analyses of biological samples, the organization of human body, the structure, ultrastructure, position and relationships of body organs.*

Applying knowledge and understanding – *The student must demonstrate the ability to*

adequately interpret and understand the possible applications of the knowledge and methodologies acquired as well as their implications in preclinical and translational research with specific reference to diagnostic and therapeutic activities.

Making judgements –*The student must develop autonomous skills in critical understanding of the structure and morphological/functional integration among different apparatuses under physiological and pathological conditions with specific reference to pathological phenotypes and their diagnostic, prognostic and therapeutic profiles.*

Communication skills – *The student should be able to clearly describe and communicate the acquired information using appropriate terminology.*

Learning skills – *The student should be able to autonomously widen an update their knowledge by using textbooks scientific papers, and online platforms (e.g. The Human Protein Atlas; Expression Atlas EMBL-EBI, MGI-The Mouse Gene Expression Information Resource Project, etc.) along with attending seminars, workshops and conferences.*

5. PREREQUISITES

Students must have acquired knowledge in basic science during their mater degree course with specific reference to: Physics, Chemistry and Biochemistry, Molecular Biology, Histology, Anatomy and Physiology. They should have acquired a good knowledge of structure and function of different organs as well as of anatomical terminology.

6. teaching methods

Teaching will mainly consist of classroom lessons. The topics listed in the program will be presented in a context preparing students for their future professional role. When possible, clinical examples and references to diagnosis and treatment of human diseases will be provided. Teaching will also take advantage of interactive methodologies, problem-based learning, self-learning and case study.

7. other information

Students may meet professors for tutoring as follows:

- ***Prof. Claudio Grassi****: Thursday, 2:00-4:00 p.m. by appointment via Secretary at ist.fisiologia.umana@unicatt.it*

- ***Prof. Claudio Sette****: Tuesday, 1.30-3 p.m. by appointment via Secretary at: cinzia.turco@unicatt.it*

- ***Prof. Marco De Spirito****: Tuesday, 1.30-3.30 p.m. by appointment via Secretary at: marialetizia.merigiola@unicatt.it*

8. methods for verifying learning and for evaluation

The exam consists of an oral test verifying the knowledge of the topics covered in the three disciplines of the course. Grade will be assigned based on the weighted average of results obtained in the three modules. Passing the exam requires a minimum grade of 18/30. A student fully answering all questions achieves the maximum score (grade: 30/30 with honors).

9. program

< Morphofunctional measures and Neurophysiology >

- *Physiological properties of central nervous system (CSN) cells.*
- *Ion channels and channelopathies: structure and function of ion channels; their role in electrogenesis; molecular and functional alterations of ion channels responsible for human diseases.*
- *Electric signals generated by neurons: "field", "patch-clamp" (voltage clamp e current clamp) and multi electrode array (MEA) electrophysiological recordings.*
- *in vitro ed ex vivo experimental models used for studying neurological diseases: primary cultures of neurons, astrocytes, neural stem cells, organotypic brain slices, 3D cultures, bioprinting.*
- *Intercellular comunicatiob in the CNS: synapsis; neuron-glia interactions; role of microvesicles and exosomes in intercellular communications among, neurons, glial cells and neural stem cells; methodologies for isolation and characterization of exosomes released from CNS cells; cargo of neural cell-derived exosomes and biomarkers of human diseases.*
- *Role of Ca^{2+} in cell excitability and intracellular signaling pathways; role of altered Ca^{2+} signaling in CNS disorders.*
- *Synaptic transmission and tripartite synapse.*
- *Synaptic Plasticity: molecular basis of long-term potentiation and depression; their changes in neuropsychiatric disorders.*
- *Structural synaptic plasticity of dendritic spines and spinogenesis: their roles in neurodevelopment, and learning; alterations of dendritic spines in in neurodegenerative diseases; use of caged compounds to study structural plasticity. .*
- *Molecular and cellular mechanisms underlying learning and memory.*
- *Adult neurogenesis: regulation of proliferation/differentiation of neural stem cells and molecular markers of these processes; modulation of adult neurogenesis under physiological and pathological conditions.*
- *Role of neuroepigenetics in brain plasticity.*
- *Engineered proteins to control CNS functions.*
- *Transgenic animal models in neuroscience: conditional and/or inducible knock-in and knock-out.*
- *Use of non-invasive brain stimulation (NIBS) techniques for neuropsychiatric diseases.*
- *Use of optogenetics and chemogenetics (Designer Receptors Exclusively Activated by Designer Drugs - DREADDs) to study CNS function and dysfunction.*
- *Behavioral tests to study higher brain functions in animal models of neuropsychiatric disorders.*

< Ultrastructural Imaging Techniques >

Confocal microscopy
- Introduction to confocal microscopy
- Fluorescent probes and antibodies for confocal microscopy
- Confocal microscopy in the context of live imaging
- Confocal microscopy and 3D imaging
- Practicals: confocal microscopy image acquisition

Electron Microscopy
- The Scanning and Transmission Electron Microscope: principles of operation
- Preparation of biological samples: fixation methods, ultramicrotomy, metallization of samples by SPUTTER-COATER.
- Applications of electron microscopy in biology (negative staining, freeze fracturing, rotary-shadowing)
- Practicals: SEM and TEM preparation
- Practicals: SEM image acquisition and morphological analysis

Data analysis.
- Digitization and image analysis
- Practicals: quantitative image analysis

< Functional Anatomy >

- *Gross Anatomy: general organization of the human body and of the functional relations between organs, with particular focus on anatomical functional relations of the Digestive System and associated glands (pancreas, liver), of the Urinary System (kidney) and of the Reproductive System (ovary and uterus).*
- *Microscopic Anatomy: structural organization of the organs in relation to their function, with particular focus to the study of specific markers of the different cell types present in the organ and of the molecular features that determine their expression (small and large intestine, pancreas, liver, ovary, uterus).*
- *Neuroanatomy: Organization of the Central Nervous System (CNS) in functional systems: sensory and motor somatic systems. Cerebral cortex: regions of neuropathological relevance; cytological organization of the cerebral cortex (laminar and columnar structure), brief introduction to embryonic cortical neurogenesis; Cerebellar cortex: development of the cerebellar cortex, cell types and organization of the cerebellar cortex, with focus on specific markers of different neuronal populations; Spinal cord and neurodegenerative disorders (Amyotrophic Lateral Sclerosis and Spinal Muscular Atrophy), biotechnological approaches for the therapy of Spinal Muscular Atrophy.*
- *Experimental neuroanatomy focused on quantitative and qualitative characteristics of pathologies, current applications and future perspectives of biotechnologies for the development of novel therapies for neurodegenerative diseases.*