a.a. 2023/2024

PHYSIOLOGY (MG0403)

1. LANGUAGE

Italian

2. Course Contents

Coordinator: **Prof. Claudio Grassi**

Year Course: II

Semester: 1° e 2°

UFC: 20

Modules and lecturers:
- PHYSIOLOGY I (MG0405) - 5 cfu - ssd BIO/09
Proff. Roberto Piacentini, Guido Maria Filippi, Cristian Ripoli, Marcello D'Ascenzo, Claudio Grassi, Maria Vittoria Podda, Lucia Leone.
- PHYSIOLOGY II (MG0406) - 13 cfu - ssd BIO/09
Proff. Cristian Ripoli, Lucia Leone, Guido Maria Filippi, Maria Vittoria Podda, Salvatore Fusco, Marcello D'Ascenzo, Claudio Grassi, Roberto Piacentini.

- PHYSIOLOGY PROFESSIONAL TRAINING (MG0407) - 1 cfu - ssd BIO/09
Proff. Marco Rinaudo, Matteo Spinelli, Fabiola Paciello, Domenica Donatella Li Puma.
- INTEGRATIVE SEMINARS (A000536) - 1 cfu - ssd BIO/09
Proff. Marcello D'Ascenzo, Maria Vittoria Podda, Guido Maria Filippi, Cristian Ripoli, Claudio Grassi, Roberto Piacentini, Lucia Leone.

3. Bibliography

Suggested books:
CONTI F. - Fisiologia Medica, Edi-Ermes
Boron W.F., Boulpaep E.L. – Fisiologia Medica, Edra

Books suggested for reference:
Kandel E. R., Schwartz J. H. e Jessell T.M. - Principi di Neuroscienze - Casa Ed. Ambrosiana
Purves D., Augustine G.J., Fitzpatrick D., Hall W.C., Lamantia A., White L.E. – Neuroscienze – Zanichelli
Berne R. M. e Levy M. N. Fisiologia, Casa Ed. Ambrosiana

4. lEARNING OBJECTIVIES

The course aims to give the student a sound understanding of the functions of the different organs and systems of the human body as well as the mechanisms underlying these functions. In addition, teaching aims to provide knowledge of the functional integration of the different apparatuses and the control mechanisms under physiological conditions, with specific reference to body

homeostasis. Moreover, such knowledge will provide the student with the basis for the study of disease mechanisms in clinical disciplines they will address in the following years.
The professional training activities will allow the student to acquire the skills for evaluation and interpretation of the main functional parameters in humans under physiological conditions, a necessary prerequisite for the understanding of pathological states.

Knowledge and Understanding ability – Teaching aims to provide knowledge of the functional integration of the different human vital functions, the molecular and cellular mechanisms underlying the functioning of various organs and systems, and the major processes of integration, regulation and homeostatic control.

Applying knowledge and understanding skills – The student must demonstrate the ability to adequately interpret and understand the possible implications of the knowledge acquired in clinical fields. The student should also demonstrate an ability to perform instrumental investigations for the assessment of physiological parameters covered by the professional training and an understanding of the principles underlying these methods.

Personal judgment – The student must develop autonomous skills in understanding the functional integrations between different apparatuses under physiological conditions and predict the body's responses to their modifications.

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

Learning ability – The student must be able to update and expand his knowledge by consulting textbooks, scientific articles and online platforms. Students are also expected to be able to self-evaluate their skills.

5. PREREQUISITES

Students must have acquired knowledge on basic disciplines in accordance with the propedeuticities established by the curriculum. In particular, knowledge of following subjects is required: Physics, Chemistry, Biology, Biochemistry, Human Anatomy and Histology.

6. tEACHING METHODS

Teaching will mainly consist of classroom lessons. The topics listed in the program will be presented in a context preparing students to their future role of medical doctors. Therefore, when possible, clinical examples will be used to explain physiological principles.

In addition, the teaching includes the following teaching activities:

1) Professional training (mandatory), organized in small groups, will enable the student to observe, learn and perform instrumental evaluations of physiological parameters, such as:
- Electrocardiogram
- Blood pressure measurement
- Auscultation of cardiac tones
- Spirometry
- Reflexes
- Visual field and visual acuity

2) Elective courses (optional; 1 UFC) characterized by an in-depth theoretical-practical study of some topics covered in the lectures.

The subjects of the elective courses are:

Structural modifications of dendritic spines in learning and memory processes (Prof. Cristian Ripoli)

Experimental models of neurodegenerative diseases: induced pluripotent stem cells and brain organoids (Dr. Domenica Donatella Li Puma)
The role of experimental animal models in the study of higher brain function (Dr. Maro Rinaudo)

3) Internship in Physiology (optional; 0.5-1 CFU)
The internship allows students to be involved in research activities performed in the laboratories of the Physiology Section of the Department of Neuroscience, for a period of six (0.5 UCF) or twelve months (1 UCF).

7. other informations

The course is organized in two channels with students being divided according to alphabetical order. Attendance to at least 5 sessions of professional training is required to be admitted to the final exam.

8. methods for verifying learning and for evaluation

The exam consists of an oral test with a committee consisting of several lecturers. The final grade will be obtained by collegial evaluation of the results obtained in the oral tests and the judgments related to professional training activities evaluated by practical and written tests. Passing the exam requires a minimum grade of 18/30. A student who fully answers all questions and has achieved excellent results in the professional training achieves the maximum score (grade: 30/30 with honors).

The requirements for achieving the maximum score (30/30 with honors) are:

Fully comprehensive answers to the questions

Critical view of the interactions between different physiological mechanisms

Excellent expository skills with reference to the terminology and logical framework of the topics covered

Highest score in professional training

9. program

PHYSIOLOGY I

Cell physiology:
- Transport of water and solutes across cell membranes
- Ion channels and electrogenesis
- The resting membrane potential
- Passive propagation of electrical signals
- Genesis and propagation of the action potential
- Synaptic transmission: neurotransmitters, transporters and receptors
- Postsynaptic potentials and their integration
- Synaptic plasticity
- Functions of the glia

Muscle system:
- Functional characteristics of skeletal, smooth and cardiac muscle
- Structural and molecular bases of muscle contraction
- Skeletal muscle: functions
- Skeletal muscle: active and passive components
- Skeletal muscle: excitability, neuromuscular transmission, end-plate potential and action potential
- Excitation-contraction coupling in skeletal muscle
- Muscle twitch and tetanus
- Length-tension and force-velocity curves
- Motor units
- Energetics of muscle contraction; muscle fatigue
- Muscle plasticity
- Action of forces applied on bone, role of constraint reactions
- Roles of the skeletal muscle system: control of bone architecture, control of joint stabilization,
- Electromyography
- Smooth muscle: structure, function, coordination mechanisms, regulation and control of contraction, latch-state
- Cardiac muscle: excitation-contraction coupling
- Mechanical properties of cardiac muscle cells

Nervous system:
- Functional organization of the nervous system
- Autonomic nervous system
- Orthosympathetic system: functions, neurotransmitters and receptors
- Parasympathetic system: functions, neurotransmitters and receptors
- Visceral reflexes
- Functions of the nucleus of the solitary tract
- Role of the hypothalamus in the control of vegetative functions

Cardiovascular system:
- Action potential of cardiac cells; functions of the specific conducting tissue
- Electrocardiogram
- Cardiac cycle: pressures and flow
- Ventricular contractility
- Tension-length and force-velocity relationships
- Heart work
- Preload and afterload in cardiac work
- Relationships between cardiac output, contractility, venous return, and atrial pressure
- Action of the orthosympathetic and parasympathetic systems on heart
- Measurement of cardiac output
- Hemodynamics; relationship between velocity, flow and cross-sectional area; origin and role of resistance to flow; blood viscosity
- Vascular elasticity and compliance; Laplace's law
- Microcirculation: architecture, function, diffusion and filtration
- Lymphatic architecture and function
- Venous return
- Blood pressure and short-, medium- and long-term regulatory mechanisms
- Interactions between cardiac output, local and systemic controls, venous return, and telediastolic volume
- Special circles: coronary circulation, musculoskeletal circulation, splanchnic circulation, cerebral circulation
- Blood: general characteristics and hemostasis

PHYSIOLOGY II

Respiratory system:
- Functional organization of the respiratory system
- Functions of the upper airways
- Lung volumes and capacities
- Respiratory muscles
- Role of the pleural cavity
- Mechanics of ventilation
- Elastic resistances of the respiratory system and role of surfactant
- Static pressure/volume curves and compliance of the lung, thorax, and thoraco-pulmonary system
- Non-elastic resistances of the respiratory system
- Respiratory work
- Alveolus-capillary gas exchanges
- Transport of O_2 and CO_2 in the blood
- Ventilation/perfusion ratio
- The role of respiration in the regulation of of acid-base equilibrium
- Respiratory adjustments during physical activity
- Nervous control of ventilation
- Chemical control of ventilation

Nervous system:
- Functional organization of the cerebral cortex
- Functional organization of sensory systems
- Somesthesia: tactile, thermal, proprioceptive and nociceptive sensitivity
- Physiology of vision, hearing, taste and smell
- Functional organization of motor systems
- The circuits of the spinal cord and brain stem; functional role of reflexes
- Organization of voluntary movement: cortical areas, cortico-spinal pathway
- Medial postural system and vestibular reflexes. Posture and locomotion
- The cerebellum and basal ganglia
- Association areas of the cerebral cortex and higher cognitive functions
- Limbic system and memory
- EEG and sleep

Renal system:
- Water-salt balance
- Functions of the kidney and role of the various components of the nephron in urine formation
- Glomerular filtration and its regulation
- Renal clearance
- Mechanisms of reabsorption and secretion at the renal tubule
- Handling of the most important plasma components while passing through the kidney
- Water reabsorption: regulation of the osmolality of urine and body fluids
- Contribution of kidney to the control of blood pH
- Contribution of kidney to the regulation of blood volume and blood pressure
- Renal regulation and self-regulation
- Urination

Gastrointestinal system:
- Functional anatomy and general principles of the gastrointestinal tract
- Enteric nervous system
- Motility of the gastrointestinal system
- Secretions of the gastrointestinal system: mechanisms of regulation
- Digestion and absorption of carbohydrates, lipids and proteins
- Energy intake, utilization and storage
- Regulation of energy metabolism and food intake

Endocrine system:
- General aspects of the endocrine function
- Hypothalamic-pituitary axis: neurohypophyseal and adenohypophyseal hormones
- Thyroid hormones
- Adrenal hormones
- Integrated responses to stress
- Regulation of calcium and phosphorus balance: parathyroid hormone, vitamin D and calcitonin

Reproductive system:
- Endocrine and paracrine control of sexual differentiation
- Puberty
- Hypothalamic-pituitary-gonadal axis
- Male reproductive system
- Female reproductive system
- Fertilization