



## **MEDTEC SHOOL**

**Course: Physiology Anatomy and Biochemistry II – PAB-II**

**Year: 2<sup>nd</sup>**

**Period : annual**

**Credits: 25**

### **Objectives**

This course faces the mechanisms and processes that sustain the survival and proper functioning of the organism, in a multidisciplinary perspective.

The student will get to know and familiarize with

- the sensory and motor systems, how they are organized and function
- the neural and endocrine regulation of bodily functions
- the distribution and exchange of substrates and gases (heart and circulatory system)
- the processes of nutrient absorption and metabolism by the digestive system
- the elimination of substances from the body and the regulation of extracellular fluid volume, pH and composition by the kidney
- the exchanges of gases at the lung and at peripheral tissues
- the complex interaction of neural, hormonal, visceral, cardiac, renal, hepatic and somatic factors in controlling blood pressure, respiration, extracellular fluid volume, cardiac output and regional distribution of blood, blood pH, glycemia, body temperature and feeding
- the main functions of the central nervous system, from vegetative control and emotional responses to the various types of memory, and from pleasure and motivation to planning, strategical control of behaviour and consciousness.

Key physical, biochemical and anatomical aspects will be addressed, either in specific lectures or in joint lectures, in a functional and Pathophysiological perspective, to help the student to acquire a comprehensive, interdisciplinary perspective. In particular, interdisciplinary lectures and seminars will be dedicated to links between clinical and technological issues, to help the students develop a creative approach toward the search for possible innovative technological strategies to cope with clinical problems.

This is an annual course, but given the very heavy study burden, it can be considered as divided into two modules:

1. Sensory and motor nervous system, endocrine system and the circadian clock, digestive system and the Biochemistry of energetic, muscular, adipose, digestive and hepatic metabolism
2. Cardiovascular, renal, respiratory systems, integrated controls (pH, temperature, blood osmolality volume and composition, glycaemia, feeding behaviour, wake-sleep cycle) and higher cerebral functions (emotions, memory, consciousness, language, behaviour control)



## Prerequisites

The student must possess the bases of maths, physics and chemistry that are needed to grasp the conceptual aspects of the regulation of the biological processes and deal with them in quantitative terms: these are the topics faced in the first year courses.

The student must possess the basic notions of macroscopic and microscopic anatomy, embryology and development, and cell biology that are needed to face the study of the functions of cells and organisms: in particular, the student must have followed the course and passed the exam of "Cell Physiology and Biochemistry I".

## Contents

### Part I – 1st Semester

- Muscle Physiol. (4 Lect. – Physiol.)
- Cell motors, extracellular matrix, connective tissues and bone (6 Lect. – Biochem.)
- Muscle, heart and brain metabolism, lactate Metabolism and comparative metabolism in tissues (3 Lect. – Biochem.)
- The digestive system (3 Lect. – Anat. + 2 Lect. – Physiol.)
  - structure, motility, nutrient absorption, secretory and endocrine activity
- Metabolic activities of the liver and GI exocrine secretions (5 Lect. – Biochem.)

A total of 45 hrs of classes will be delivered, 14 of which in the form of joint multidisciplinary lectures

### Part II – 2nd Semester

- Sensory receptors, sensory modalities, and sensory pathways (4 Lect. – Anat.)
- Synaptic biochemistry and synaptic scaffolding proteins (1 Lect. – Biochem.)
- Touch, nociception, proprioception (Physiol. – 2 Lect.)
- The hearing system (2 Lect. – Anat.)
- Acoustics, hearing and sound processing (2 Lect. – Physiol.)
- Vestibular organs and neural pathways (1 Lect. – Anat.)
- The eye and the visual system (3 Lect. – Anat.)
- Optics and Sight (3 Lect. – Physiol.)
  - photoelectric transduction, image processing, object recognition and location
- Chemoceptors, smell and taste (1 Lect. – Anat., 1 Lect. - Physiol.)
- Vestibular information, balance, posture and gaze control (2 Lect. – Physiol.)
- Movement control (3 Lect. – Anat.)
  - the descending pathways, the cerebellum, the basal ganglia
- Motor control (4 Lect. – Physiol.)
  - the hierarchical motor system CPGs, locomotion, posture
  - the cerebellum and the basal ganglia
  - conditioning and motor learning
- Brain vascularization (2 Lect. – Anat.)



- Blood brain barrier and the roles of glia (1 Lect. – Physiol.)
- The endocrine system (8 Lect. - Physiol.)
  - general organization, hypothalamus and hypophysis, growth hormone, sex hormones, corticosteroids, thyroid hormones, the circadian cycle, control of glycemia
- Genital organ anatomy (2 Lect. – Anat.)
- Endocrine Biochem. and the nuclear receptor family (3 Lect. – Biochem.)
- Energy balance, lipid metabolism and the storage, thermogenic and endocrine roles of adipose tissue (4 Lect. – Biochem.)
- Anat. of the heart and circulatory system (3 Lect. – Anat.)
- Fluid-dynamics and the mechanical activity of the heart (6 Lect. – Physiol.)
- Electrical activity of the heart, ECG and regulation of heart function (4 Lect. – Physiol.)
- Plasma biochemistry (2 Lect. – Biochem.)
- The circulatory system (2 Lect. – Physiol.)
  - resistance and capacitance vessels, microcirculation, transcapillary exchanges, local control of vascular tone
- Anat. of the kidney and urinary system (2 Lect. – Anat.)
- The kidney and the regulation of plasma and fluid volume and composition (6 Lect. – Physiol.)
  - renal circulation, glomerular filtration, transport systems in the tubule
  - sodium and water balance, blood pressure control
  - the regulation of body pH
  - micturition
- Anat. of the respiratory system (2 Lect. – Anat.)
- The respiratory system (5 Lect. – Physiol.)
  - respiratory mechanics, gas exchanges, ventilation / perfusion
- Cancer metabolism (2 Lect. – Biochem.)
- Integrated controls – The autonomic nervous system and the hypothalamus (2 Lect. – Physiol.)
  - control of body temperature and feeding
- Notions about Personalized Medicine and the microbiota (2 Lect. – Biochem.)
- The Central Nervous System – Learning and Memory (2 Lect. – Physiol.)
- Integrated controls – The Central Nervous System (6 Lect. – Physiol.)
  - ascending projections from the brainstem
  - sleep, coma, cortical arousal, selective attention
  - limbic circuits and emotions
  - dopamine: pleasure and motivation
  - serotonin in the CNS
  - the Electro-Encephalogram
  - pain as a symptom, and emotion and a pathology
- Language, thought, consciousness and the control of behaviour (3 Lect. – Physiol. )

A total of 260 hrs of classes will be delivered, among which at least 40 hrs will be in the form of joint, multidisciplinary or interdisciplinary classes.

## Teaching Methods

- Lectures
- Indication of readings
- Personal and group assignments – quizzes, research assignments, open questions, self-evaluation
- Interactive and multidisciplinary re-elaborations
- Flipped classrooms
- Formative revision tests, Question time

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The course is organized on three distinct levels:

1. knowledge transfer – Lectures (whether given in presence, in streaming or recorded) will remain accessible to students online; students will also be addressed to textbook chapters, scientific articles and other studying material: through all this the students are expected to acquire the notions needed to master the topics at hand  
All these activities will be programmed in the daily schedule; however, they can be performed by the students at the times most convenient for them, if they are residing in other Countries
2. active knowledge mastering – self-assessment tests, small-group (either physical or digital) assignments and didactic material for flipped classrooms will help the students process and master the acquired notions
3. knowledge activation – interactive lectures, joint interdisciplinary seminars, question and answer sessions, discussions of group assignments and the actual flipped classrooms will help the student to fully understand, assimilate and frame the acquired notions in an organized general perspective, and to clearly and linearly explain the complex issues of the functioning of the organs and systems and of the organism as a whole.

Knowledge activation sessions will be held on Campus in the afternoon (Italian time) to make online synchronous attendance easier from most Countries in the world.

A significant fraction of the activities will see the contribution of more than one teacher, from different disciplines, to help the students to acquire a multidisciplinary perspective and curiosity toward novel ideas and developments.

## Verification of learning

Learning by the students will be monitored during the course through the assignments and interactive sessions and will be eventually assessed through a written and oral examination.

In order to access the exam the student must have completed the assignments given during the course.

The exam is comprised of four parts:

1. Module 1: written test
2. Module 2: written test
3. Practical exam at the microscope
4. Final oral interview



### **Module 1.**

- Topics: sensory and motor nervous system; endocrine system and the circadian clock; digestive system (Anatomy and Physiology); Biochemistry of energetic, muscular, adipose, digestive and hepatic metabolism
- Written test: The test consists of 45 questions. Multiple Choice with single or multiple correct answers or Matching Test. Time allotted: one hour.

### **Module 2.**

- Topics: cardiovascular, renal and respiratory systems; integrated controls: pH, temperature, blood osmolality, volume and composition, glycaemia, feeding behaviour, wake-sleep cycle; higher cerebral functions: emotions, memory, consciousness, language, behaviour control
- Written test: The test consists of 45 questions. Multiple Choice with single or multiple correct answers or Matching Test. Time allotted: one hour.

### **Practical exam at the microscope:**

Description and diagnosis of histological preparations. Students' ability to describe and diagnose histological preparations at the microscope will be evaluated.

The result will be pass or fail. Passing this test is necessary to access the final interview.

### **Final oral interview**

Aimed at checking understanding and capability to explain to a patient, a nurse, a colleague, how structural aspects, biophysical and biochemical mechanisms and physiological processes contribute to the normal and altered functions in the organism. Knowledge, clarity, appropriateness and conceptual organization will be evaluated.

### **Marks.**

- At least 30 correct answers out of 45 (2/3) must be given in written tests. The mark will be computed as 18 (sufficient) + the number of correct answers in excess of 30.
- The written and practical tests can be sit at different times and in any order
- In order to access the oral interview, the other three parts of the exam (Module 1, Module 2 and practical test at the microscope) must have been passed within the last 12 months.
- The final interview may modify the average score by no more than of +/- 3.

## **Texts**

- Guyton and Hall – Textbook of Medical Physiology, 13th ed. Elsevier, 2016.
- W.F. Boron, E.L. Boulpaep – Medical Physiology, 3rd ed. Elsevier, 2017.
- E.R. Kandel, J.H. Schwartz et al. – Principles of neural science. McGraw Hill 2013.
- Ross and Pawlina – Histology A Text And Atlas - With Correlated Cell And Molecular Biology, 8th ed. Lippincott Williams & Wilkins, 2018.