



MEDICINE AND SURGERY

Course: Body at Work 2

Year : 2nd

Period : 2nd semester

Credits: 12 (Anatomy 1, Physics 1, Biochemistry 4, Physiology 9)

Objectives

This second part of the *Body at Work* course faces the mechanisms and processes that sustain the survival and proper functioning of the organism. The main aspects are 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.

The course includes Collaborative Learning sessions and integrated lectures on specific Priority Presenting Problems. The collaborative learning effort is aimed at promoting meaningful learning by the students, making use of conceptual maps (CMAP) to organize complex sets of information by creating a hierarchy and linking information from different domains. Such training in facing a clinical problem, and sharing and discussing information, should help them reach a higher level of learning and understanding.

The course also includes PhysioLab experiences to practice with physiological measurements.

Professionalizing activity: the course includes two practical activities on the physical examination of the abdomen, thorax and heart. These activities build on the knowledge acquired during previous courses and the anatomical and functional content of this course, and help the students to further proceed in acquiring the basic skills of the general physical examination.

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 the in quantitative terms: these are the topics faced in the PLM course (Principles of the Living Matter).



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: these are the topics treated in the BA (Body Architecture), BB (Building Bodies) and CMP (Cells Molecules and Processes) courses.

In addition, the student must have followed the “Body at Work 1” course that introduces the conceptual, cellular and physiological aspects that are needed to understand the functioning of organs and systems

Contents

P = Physics – A = Anatomy – B = Biochemistry – Φ = Physiology – G = Group work – J = Joint – C = Collaborative learning – F = flipped class – CL = Clinical links; numbers = hours

The endocrine system 16 Φ +12B

- describe the general organization of the endocrine system and feedback loops
- examine the hormones of the hypothalamus and hypophysis
- understand the biological clock, the endocrine control of growth, development, sexual maturation and reproduction
- understand the function and regulation of adreno-cortical and thyroid hormones

CL: Jet-lag and shift work, birth control, Cushing and Addison's diseases, goitre

The cardiovascular system 8P + 6B + 20 Φ + 8JA Φ + 2 PhysioLab

- understand the principles of fluid-dynamics and the mechanical activity of the heart
- discuss heart sounds and murmurs
- overview the cardiac metabolism and the process of cardiac remodeling

CL: valvular heart diseases, cardiac failure, ischemic heart disease

- describe the cellular bioelectric properties of “slow” and “fast” cells in the heart
- understand the generation and propagation of the A.P., the genesis of arrhythmias, the ECG
- explain how heart rate and contractility are regulated by the autonomous nervous system

CL: arrhythmias

PhysioLab: Learn to read an ECG

- understand capillarity, the concept of viscosity, turbulence and Reynolds number
- examine the plasma and its components, haemostasis and the role of the endothelium
- discuss flow resistance and compliance of blood vessels, pressure, resistance, flow
- examine arterial pressure, intravascular volume, the pulse shape along the circulatory tree
- understand exchanges in the microcirculation, Starling's forces and the role of lymphatics

CL: Oedema

J (A+ Φ): Understanding the heart through congenital heart defects

J (A+ Φ): Shock

The digestive system 8B+4 Φ



- describe GI motility and the exocrine and endocrine secretions in the digestive system
- review the activities of the liver, its energy metabolism, biosynthetic and catabolic activities
- describe ethanol absorption, tissue distribution, and metabolism

CL: liver cirrhosis, alcoholism

The kidney and body fluids 2P+12Φ + 4JAΦ

- examine the fluid balance in the body, the mechanisms of diffusion and filtration, the concept of clearance
- understand how the kidney selectively disposes of endogenous and exogenous substances
- explain renal autoregulation, GFR and urinary volume
- discuss the transport systems in the portions of the tubule and their specific functions
- describe the renin-angiotensin-aldosterone system and its renal and systemic actions
- understand micturition, the control of thirst and kidney role in blood pressure regulation
- understand the control of pH, alkaline reserve, respiratory and metabolic acidosis / alkalosis

CL: proteinuria, diuretics, acid-base disorders

J (A+Φ): Understanding the kidney through the nephrotic and nephritic syndromes 4J A/L

The respiratory system 2P + 8Φ +4JAΦ +2 PhysioLab

- understand the physics of breathing and the concepts of compliance and resistance
- describe the physics of the alveolus, the equation of Laplace, the case of surfactants
- spirometry, volumes and capacities, pressure-volume curves
- examine gas composition of inspired, alveolar and expired air.
- understand gas exchanges, transport and diffusion into and from the tissues
- explain the relation between respiratory exchange ratio and metabolism

CL: emphysema, fibrosis, acute respiratory distress syndrome (ARDS)

- discuss pressures and blood flow in the pulmonary circulation
- describe the neural mechanisms responsible for the generation of the breathing pattern.
- explain how respiratory activity is modulated by central and peripheral inputs

CL: Ventilatory adaptation to high altitude

- placental circulation and gas exchanges with the foetus

PhysioLab: Spirometry

J (A+Φ): understanding the respiratory system through COPD

Integrated aspects – The ANS, the hypothalamus, feeding, cancer, microbiota, personalized medicine
4Φ+8B+4C+4JBΦ

- describe the hierarchical organization of the ortho/parasympathetic systems and its actions
- define the internal core temperature and the balance between heat input and output
- examine “sweating” and “shivering” as mechanisms of thermal regulation
- discuss the many hormones involved in the regulation of feeding behaviour.

CL: Fever vs Hyperthermia



J(B+Φ): obesity and metabolic syndromes

- Understand key metabolic properties and reprogramming of cancer cells
- understand principles of personalized medicine and its implementation
- understand the microbiota, its main metabolic pathways and its metabolic impact

Integrated controls – The Central Nervous System 6Φ+2PhysioLab

- describe and understand the ascending aminergic projections from the brainstem (ARAS)
- discuss the roles of NA, AD, ACh, 5-HT, HA in regulating cortical activity and functions
- understand arousal and coma and the control of the sleep/waking cycle
- discuss the cortico-thalamic / thalamo-cortical dialogue and selective attention
- understand the role of hypothalamus, amygdala and limbic circuits in emotions and feelings

CL: Anxiety and the Post-Traumatic Stress Disease

- understand the hippocampus (explicit memory and contextualization)
- classify the various “types” of memory and memory encoding, recall, consolidation
- discuss mesencephalic dopamine: pleasure and motivation
- understand the roles of serotonin in the CNS

CL: Bipolar Spectrum Disorders

PhysioLab: The Electro-Encephalogram

Pain - Anatomy / Physiology workshop 4J(A+Φ)

- revise the organization of nociceptors and their transduction mechanisms
- examine the concepts of hyperalgesia, allodynia, nociceptive wind-up, chronic pain
- revise and the ascending nociceptive paths and descending control

Consciousness and the control of behaviour 3Φ + 6J

- examine the concept of “working memory” and the circuits and functions involved in it
- examine the neurophysiological basis of “primary consciousness”, conscious thought and planning, extended consciousness as a unitary, diachronic image of reality and the self

CL: Autism Spectrum Disturbances and Schizophrenia

- understand the “external” and the “internal” paths of behavioural control: the sensory-motor function of the parietal cortex – object “affordance” – movements vs. “actions”
- understand the role of basal ganglia in behaviour initiation, choice, conciliation, shifting
- understand the origin of endogenously programmed behaviour (the “internal” path)

CL: Attention Deficit and Hyperactivity Disorder (ADHD)

J: Altered Mental Status: Understand the possible sources of a quantitative or qualitative alteration in mental status

J: Substance abuse: Understand the mechanisms that lead from recreational use of a drug to addiction, and the basis of compulsive behaviours in general



Teaching Methods

- Lectures
- Indication of readings
- Personal and group assignments – quizzes, research assignments, open questions, self-evaluation
- Interactive and multidisciplinary re-elaborations
- Formative revision tests, Q&A
- Flipped classrooms
- PPP portfolio collaborative learning/CMAPS
- Practicals (Neurological examination)
- PhysioLab (Electrocardiogram, Spirometry, Electroencephalogram)
- Material needed – n.a.

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 living systems.
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.

The student will be asked - through specific assignment during the courses and in the oral interview at the exam - to explain the processes and mechanisms that they encounter during the classes. This will boost the student's capacity of communicating clearly and simply even complex topics, an indispensable skill of a medical doctor.

The course also includes PhysioLab experiences to practice with physiological measurements.

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 required PPP portfolio activities and the assignments given during the course.

The exam is comprised of three parts:

1. Evaluation of the skills on the neurological examination of the patient
2. Written examination: Multiple Choice Questions or similar tests
3. Oral examination
 1. Physical examination: this part of the exam consists in a passed or failed evaluation. Students will be asked to perform part of the checklist they have learned during the Practicals. This part of the exam must be passed to proceed to the written part.
 2. Written part: Multiple Choice Question or similar test. The test consists of 60 items (15 Anatomy, 10 Physics, 10 Biochemistry, 25 Physiology). Time allotted: 90 minutes. In order to pass the written test, 2/3 of the questions must be answered correctly (40/60); 60% of the correct answers must also be given for each discipline (9/15 Anatomy, 6/10 Physics, 12/20 Biochemistry, 15/25 Physiology). Occasionally, thresholds might be lowered, in case of anomalous average, best and worst performances. Only students who pass the written test will access the oral examination. The mark obtained in the written test will be taken into consideration in the final evaluation; however, it will neither determine the final mark nor grant success.
 3. Students who passed the written test do not need to repeat it if they take the oral during the same exam session. The oral interview will assess the competence of the student in explaining how the structural aspects, the biophysical and biochemical mechanisms and the physiological processes contribute to the functions of cells, neurons, sensory systems, muscles and motor control.

Since failing this exam implies repeating the second year, on the last exam session only the students will be given the opportunity of an oral interview even if they failed the written test, to confirm the judgement and discuss their learning performance and possible problems for tutoring. An extra-session in the first week of October will be set up to give a final opportunity to students who failed all previous sessions. Only students who did attend (and failed) the last session in September will be admitted to this extra session.

Texts

Anatomy, Physics and Biochemistry:

Refer to first year textbooks

Physiology:

- Guyton and Hall – Textbook of Medical Physiology. By John E. Hall, 13th Edition. 2016. Elsevier Health Sciences. 1168 pp. ISBN: 978-1-4557-7005-2 / 978-1-4557-7016-8.
- Walter F. Boron & Emile L. Boulpaep. Medical Physiology, 3rd Edition. 2016. Elsevier Health Sciences. 1312 pp. ISBN: 978-1-4557-4377-3.



Neurosciences :

- Eric R. Kandel e James H. Schwartz. Principles of neural science. 5th Edition 2012. McGraw-Hill. ISBN 10: 9780071390118 / 13: 9780071390118.
- Michael S. Gazzaniga e George R. Mangun. The cognitive neurosciences. 5th Edition. 2014. Mit Press Ltd. 1128 pp. ISBN: 9780262027779