# *Syllabus Master's Degree Course in Medicine and Surgery*

## BODY FUNCTIONS 2

Second year, second semester (14 academic credits [CFU])

### Teachers

| Subject | Academic credits (CFU) | Lecturer |
|---|---|---|
| Human physiology | 7 | PUZZO Daniela<br>TROPEA Maria Rosaria |
| Organ structure | 4 | D'AGATA Velia |
| Biochemistry | 3 | AMORINI Angela Maria |

### Learning outcomes

| Subject | Learning outcomes |
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| Human physiology | By the end of the course, students are expected to:<br>• Know how the living organism achieves and maintains homeostasis in relation to internal and environmental changes.<br>• Understand the functioning mechanisms of individual cells, tissues, organs, and the integration between them.<br>• Know the functioning of the cardiovascular, respiratory, renal, gastrointestinal, and endocrine systems and their interactions.<br>• Be able to assess the nutritional characteristics of foods, nutritional status, energy expenditure, energy requirements, and the physiological use of nutrients in the diet.<br>• Understand the adaptations of the body during physical exercise and under extreme conditions.<br>• Understand the experimental approach and the potential to translate basic science findings into clinical practice.<br>• Be able to apply acquired knowledge to clinical practice (pathophysiological implications). |
| Organ structure | By the end of the course, students are expected to:<br>• Describe the anatomy and functional organization of the alimentary system.<br>• Understand the structural and functional aspects of the urinary system.<br>• Explain the anatomy and roles of the male genital system.<br>• Describe the anatomy and functions of the female genital system. |

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| | • Understand the structure and regulation of the endocrine system.<br><br>At the end of the course, the student will understand the topography, structural organization, and functional integration of the alimentary, urinary, male and female genital, and endocrine systems. The student will also comprehend the spatial relationships of these organs with adjacent structures. |
| Biochemistry | By the end of the course, students are expected to:<br><br>• Understand the integration, hormonal control and intracellular environment/signaling relationship in glucose, lipid and protein metabolism<br>• Understand the different metabolic specialization of the organs, in physiological and pathological situations.<br>• Get insights into the fate of heme and nitrogenous bases.<br><br>At the end of the course, the student will understand the behavior of different organs to different stimuli. |

## Prerequisites

| Subject | Prerequisites |
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| Human physiology | Attainment of the educational objectives set by prerequisite courses. |
| Organ structure | |
| Biochemistry | |

## Course contents

| Subject | Course contents |
|---|---|
| Human physiology | **Blood and Lymph**<br>• Blood composition: cellular components and liquid part, hematocrit, plasma proteins and electrophoretic proteinogram, main laboratory tests, blood count.<br>• Red blood cells: erythropoiesis and iron metabolism, hemocateresis, hemolysis, respiratory functions of red blood cells, hemoglobin's affinity for respiratory gases, oxygen uptake and release by hemoglobin. Physiopathological implications: anemia.<br>• White blood cells: distribution and leukocyte formula, functions. Physiopathological implications: infections.<br>• Platelets: functions, hemostasis, and coagulation. Physiopathological implications: antiplatelet and anticoagulant drugs.<br>• The lymphatic system: lymphatic stations, composition, and function of lymph. Blood-tissue barrier.<br><br>**Cardiovascular system**<br>• Electrical function of the heart: excitability, cardiac automaticity, and pacemaker cells, refractory periods, conduction.<br>• Mechanical function of the heart: cardiac cycle, valve movements and pressure variations in atria and ventricles during the phases of the cardiac cycle, duration of the phases, cardiac output, Starling's law of the heart, Laplace's |

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| | law applied to the heart. Cardiac output determination and commonly used methods.<br>• Heart sounds: auscultation sites and characteristics. Physiopathological implications: valvular insufficiency and stenosis.<br>• Heart properties: chronotropy, bathmotropy, dromotropy, inotropy.<br>• Pharmacology: beta-blockers, calcium channel blockers, digitalis.<br>• Neural control of the heart: autonomic nervous system, brainstem and hypothalamic centers, reflex regulation of the cardiovascular system.<br>• Heart work, metabolism, and oxygen consumption.<br>• Electrocardiography: Einthoven's triangle, leads, standard electrocardiographic conventions, common trace analysis, axis determination and its functional significance. Echocardiogram. Physiopathological implications: flutter, fibrillation, extrasystole, bundle branch block, myocardial infarction.<br>• Systemic arterial pressure: systolic, diastolic, differential, mean. Short and long-term regulation mechanisms (chemoreceptors, baroreceptors, renin-angiotensin-aldosterone system, bradykinin, catecholamines, dopamine, serotonin). Arterial pulse. Blood pressure determination. Physiopathological implications: arterial hypertension.<br>• Venous system: venous distensibility, posture effects on veins, venous return, phlebogram, venous pressure and its variations, jugular pulse. Physiopathological implications: venous insufficiency.<br>• Special vascular circuits: regional distribution of cardiac output, coronary, cerebral, cutaneous, muscular, hepatosplanchnic, pulmonary, renal, splenic, and fetal circulation.<br><br>**Respiratory system**<br>• Respiratory mechanics: General considerations. Functions of the upper airways. Generation of pressure gradients: eupneic inspiration and expiration. Role of respiratory muscles and pleura. Elastic recoil of the lung. Airway resistance. Effects of surface tension on respiration and surfactant's role. Definition of pulmonary compliance and elasticity with clinical applications. Spirometry: lung volumes and capacities. Forced spirometry and pulmonary function tests, notes on obstructive and restrictive conditions. Physiopathology examples for understanding physiological mechanisms.<br>• External and internal respiration: ventilation-perfusion matching, V/Q ratio and regulatory mechanisms, alveolar compartment, the role of membrane thickness and surface area in gas exchange. Gas partial pressures, solubility, and physical laws applied to respiratory physiology. Role of red blood cells and hemoglobin. Recap of hemoglobin function, oxygen dissociation curve, oxygen saturation, and clinical implications. Hypoxia definition, types of hypoxia, and clinical repercussions.<br>• Regulation of respiration: Definition of key neural structures for generating respiratory patterns: pneumotaxic and apneustic centers, dorsal and ventral respiratory groups. Neural signal generation and mechanical transduction: respiratory frequency and depth. Central and peripheral |

chemoreceptors. Other regulatory mechanisms: stretch receptors, irritant agents, juxtacapillary receptors, muscle proprioceptors. Voluntary control of respiration. Hypothalamic and emotional regulation of respiration.
- Clinical applications of respiratory physiology: Respiratory changes during exercise and at high altitude. Clinical examples of pathological breathing patterns and dyspnea. Respiratory assistance devices. Notes on cardiopulmonary resuscitation.

**Urinary system**
- Renal functions: General overview. Notes on functional anatomy. The nephron as the kidney's functional unit. Differences between cortical and juxtamedullary nephrons. Renal vasculature.
- Glomerular functions: Mechanisms of glomerular filtration. Effective filtration pressure, characteristics of the ultrafiltrate, and resistances to tubular fluid flow. Glomerular filtration rate. Inulin and creatinine clearance. Mechanisms modifying the ultrafiltrate volume. Filtered load concept and its functional significance.
- Tubular functions: Reabsorption processes at the proximal tubule. Active and passive transport. Renal threshold and tubular transport maximum concepts. Glucose reabsorption and glycosuria. Facultative reabsorption in the distal tubule. Aldosterone's action. Urine concentration. Henle's loop and countercurrent multiplication mechanism. Vasa recta and countercurrent exchange. Vasopressin's action. Tubular secretion (hydrogen ions, potassium, ammonium ion). Urine acidification.
- Renal circulation: Extrinsic control and autoregulation of renal blood flow in relation to systemic blood pressure (myogenic mechanism and tubuloglomerular feedback).
- Systemic functions of the kidney: Control of systemic arterial pressure, osmolarity, and composition of body fluids. Erythropoietin production. Endocrine functions.
- Applied renal physiology: Renal function tests (clearance concepts and their application in assessing glomerular, tubular, and vascular function). Significance of glucose and water load. Osmotic and water diuresis. Fluid deficit (dehydration) and its general consequences. Fluid excess (water intoxication, edema). Notes on pharmacology: diuretics.
- Bladder physiology: filling and emptying, nervous system action, paralytic bladder, cystogram.

**Gastrointestinal system, Metabolism, snd Nutrition**
- Digestive processes: Digestive tract. Chewing. Salivary secretion, composition, and function of saliva. Conditioned reflexes. Swallowing. Gastric filling. Gastric movements. Gastric secretion and its neural/hormonal regulation. Pancreatic secretion: secretin and pancreozymin, pancreatic juice. Secretion of the small intestine and colon. Intestinal motility. Gastrointestinal hormones.
- Gastroenteric nervous system: Intrinsic and extrinsic innervation. Endoluminal pressure regimes. Villi movements. Types of intestinal movements. Esophageal, gastric, and intestinal motility. Myogenic and neurogenic mechanisms of

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| | intestinal movement. Visceral reflexes. Colon motility. Defecation.<br>• Liver: The liver's functional unit. Hepatic arterial and portal circulation. Overview of liver functions. Hepatic metabolism, protein synthesis, and storage function. Biotransformation of drugs and toxins. Liver's role in hemopoiesis and blood coagulation. Bile synthesis and excretion. Hepatic and cystic bile. Enterohepatic circulation. Hemoglobin breakdown: jaundice and its various forms.<br>• Metabolism: Overview of the general chemical characteristics of carbohydrates, lipids, and proteins. Carbohydrate metabolism: food carbohydrates, digestion processes, absorption, and metabolic fate. Lipid metabolism: digestion, absorption, and metabolic fate. Protein metabolism: digestion, absorption, and metabolic fate.<br>• Nutrition: Principles of dietetics. Energy requirements. Normal diet composition. Nutritional needs under special conditions (pregnancy, breastfeeding, childhood, old age, etc.). Mechanisms of hunger and satiety.<br><br>**Ph regulation**<br>• Control of intracellular and extracellular pH, buffer systems, acid-base balance disorders (respiratory and metabolic acidosis and alkalosis), and compensation mechanisms. Exercises: blood gas analysis (BGA) comprehension.<br><br>**Thermoregulation**<br>• Regulation of body temperature in humans, physiological and pathological variations in body temperature, thermal balance, thermogenesis, thermolysis, temperature regulation, responses to heat and cold.<br><br>**Adaptations**<br>• Adaptations to physical exercise. Body’s responses to physical exercise (cardiovascular, respiratory, plasma, muscular responses), pathologies induced by inactivity. Adaptations to high altitude, body’s responses to altitude, mountain sickness. Adaptations underwater. Hyperbaric gas physiology, hyperbaric syndrome. Effects of zero gravity.<br><br>**Endocrine system**<br>• **Hormone Overview**: Definition and classification of hormones. Hormone biosynthesis, secretion, and transport. Hormonal activation and inactivation. Mechanisms of hormone action. Homeostasis of hormonal regulation. Hormonal interactions. Neuroendocrinology. Functional anatomy of the hypothalamus, pituitary gland, and ependymal organs of the third ventricle. Brief notes on pathophysiology.<br>• **Thyroid Gland**: Functional anatomy. Iodine metabolism. Regulation of thyroid function. Thyroid hormones and their physiological effects. Interaction of the thyroid with other endocrine systems. Brief notes on pathophysiology.<br>• **Adrenal Cortex**: Functional anatomy. General steroid biosynthesis. ACTH. Glucocorticoids. Mineralocorticoids. Adrenal sex steroids. Brief notes on pathophysiology.<br>• **Calcium and Phosphate Metabolism**: Calcium, phosphate, and other skeletal ion metabolism. Bone physiology. Parathyroid hormone (PTH). Calcitonin. Vitamin D. Other |

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| | hormones influencing mineral and bone homeostasis. Brief notes on pathophysiology.<br>• **Endocrine Pancreas**: Functional anatomy. Beta cells and insulin. Insulin functions. Alpha cells and glucagon. Mechanism of action of glucagon. Relationships between pancreatic glucagon and enteroglucagon. Delta cells and somatostatin. Brief notes on pathophysiology.<br>• **Prostaglandins**: Endocrine role.<br><br>**Reproductive system**<br>• **Female Reproductive System**: Function of female reproductive organs. Ovarian cycle. Ovary function. Puberty. Menopause. Functions of the fallopian tubes. Menstrual cycle. Estrous cycle. Chemistry and functions of ovarian steroid hormones. Physiology of sexual intercourse. Contraception. Extra-ovarian hormonal influences on the ovary. Pregnancy physiology. Lactation and its regulation. Brief notes on pathophysiology.<br>• **Male Reproductive System**: Function of male reproductive organs. Spermatogenesis. Seminal pathways and accessory glands. Puberty. Physiology of sexual intercourse. Extra-testicular hormonal influences on the testicles. Actions of androgens and effects of testicular removal. Brief notes on pathophysiology. |
| Organ structure | • Alimentary system: mouth, appendages of the mouth, salivary glands, pharynx, esophagus, stomach, small intestine, large intestine liver extrahepatic ducts pancreas peritoneum<br>• Urinary system: kidneys, urinary tract urinary bladder<br>• Male genital system: testis, spermatic pathways, glands annexed to the spermatic pathways, external genitalia<br>• Female genital system: ovary, uterine tubes, uterus, vagina, external genitalia<br>• Endocrine system: pituitary gland, pineal gland, thyroid gland, parathyroid gland, pancreatic islets, suprarenal glands, paraganglia, glomera diffuse endocrine system |
| Biochemistry | • Heme biosynthesis and catabolism: related diseases<br>• Blood biochemistry<br>• Liver, muscle and kidney biochemistry: roles and interconnections<br>• Nucleotide metabolism: "de novo" biosynthesis of pyrimidine nucleotides and its regulation. De novo biosynthesis of purine nucleotides and interconversion. Base recovery route and related diseases. Catabolism of purine nucleotides and acid uric; hyperuricemia (primary, secondary gout).<br>• Signal transduction pathways. |

## Assessment methods

| Subject | Assessment methods |
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| Human physiology | The final assessment of acquired knowledge is conducted by an oral exam. The grade is expressed on a scale of thirty, up to a maximum of 30/30 cum laude (with honors). The final grade is determined by the weighted average of the scores obtained in the course subjects.<br><br>The oral examination consists of an interview during which questions will cover at least three different topics from the course curriculum. The assessments aim to evaluate: i) the level of knowledge in the disciplines; ii) the ability to apply this knowledge to solve specific |
| Organ structure | |
| Biochemistry | |

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| | problems related to the disciplines (autonomous problem-solving); iii) clarity of expression; iv) proficiency in medical-scientific language. The assessment of learning can also be conducted remotely if the conditions necessitate it.<br><br>For the assignment of the final grade, the following parameters will be considered:<br><br>• Score 29-30 with honors: The student demonstrates an in-depth knowledge of the topics, promptly and correctly integrates and critically analyzes presented situations, independently solving even highly complex problems. They possess excellent communication skills and command medical-scientific language proficiently.<br>• Score 26-28: The student has a good understanding of the topics, is able to integrate and critically and logically analyze presented situations, can fairly independently solve complex problems, and presents topics clearly using appropriate medical-scientific language.<br>• Score 22-25: The student has a fair understanding of the topics, although it may be limited to the main areas. They can integrate and critically analyze presented situations, although not always in a linear fashion, and present topics fairly clearly with moderate language proficiency.<br>• Score 18-21: The student has minimal knowledge of the topics, possesses modest ability to integrate and critically analyze presented situations, and presents topics sufficiently clearly, although their language proficiency may be underdeveloped.<br>• Exam not passed: The student lacks the minimum required knowledge of the core content of the course. Their ability to use specific language is minimal or nonexistent, and they are unable to independently apply acquired knowledge. |

## Examples of common questions and/or exercises

| Subject | Examples of common questions and/or exercises |
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| Human physiology | • Discuss the physiological mechanisms that regulate blood pressure.<br>• Discuss the cardiac cycle.<br>• Describe the physiological mechanisms underlying glomerular filtration. |
| Organ structure | • Describe the external morphology of the liver<br>• Describe the macroscopic and microscopic structure of the kidney<br>• Describe the macroscopic and microscopic structure of the testis |
| Biochemistry | • Regulation of ketogenesis.<br>• Degradation of heme<br>• Recovery of nitrogenous bases |

## Reference texts

| Subject | Textbooks |
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| Human physiology | • Hall, J. E. Guyton and hall textbook of medical physiology. W B Saunders.<br><br>Any additional educational material (slides, videos, handouts, etc.) will be distributed or indicated during the lessons. |

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| Organ structure | • Anastasi et al., Human Anatomy, edi-ermes<br>• Richard Drake A. Wayne Vogl Adam Mitchell. Gray's Anatomy for Students - Elsevier.<br>• Susan Standring. Gray's Anatomy - The Anatomical Basis of Clinical Practice. - Elsevier.<br><br>Any additional educational material (slides, videos, handouts, etc.) will be distributed or indicated during the lessons.Any additional educational material (slides, videos, handouts, etc.) will be distributed or indicated during the lessons. |
| Biochemistry | • Alisa Peet, Michael Lieberman- Marks' basic medical biochemistry fifth edition- Lippincott Williams and Wilkins<br>• Devlin, T. M. Textbook of Biochemistry With Clinical Correlations, John Wiley and Sons.<br>• David L. Nelson; Michael M. Cox. “Lehninger Principles of Biochemistry”, W. H. Freeman & Co.<br>• Voet D, Voet JG, Pratt CW. “Voet's Principles of Biochemistry, Global Edition”, Wiley.<br><br>Any additional educational material (slides, videos, handouts, etc.) will be distributed or indicated during the lessons. |

## Course format

| Subject | Course format |
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| Human physiology | The teaching will primarily be conducted through in-person lectures with a blend of theory and practical exercises. In the event that teaching is delivered in a blended or remote mode, necessary adjustments may be introduced compared to what has been previously stated, in order to adhere to the planned program as outlined in the Syllabus. |
| Organ structure | |
| Biochemistry | |

## Attendance

| Subject | Attendance |
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| Human physiology | Mandatory attendance. |
| Organ structure | |
| Biochemistry | |

## Course schedule

| Subject | Course schedule |
|---|---|
| Human physiology | Program topics from recommended textbooks and handouts provided by the teachers. |
| Organ structure | • Alimentary system-chapter 7 of Anastasi et al., Human Anatomy, edi-ermes)<br>• Urinary system-chapter 9 of Anastasi et al., Human Anatomy, edi-ermes<br>• Male genital system-chapter 10 of Anastasi et al., Human Anatomy, edi-ermes<br>• Female genital system-chapter 11 of Anastasi et al., Human Anatomy, edi-ermes |

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| | • Endocrine system chapter 12 of Anastasi et al., Human Anatomy, edi-ermes |
| Biochemistry | Program topics from recommended textbooks and handouts provided by the teachers. |