HUMANITAS UNIVERSITY	**Department of Biomedical Sciences** **Physiotherapy Degree Programme** **Human Physiology Syllabus**

Academic year 2020-2021. Academic term: second semester of the first year
Course coordinator: Dr Roberta Monzani

GENERAL PHYSIOLOGY (5 ECTS)	
Dr Roberta Monzani	Adjunct Professor of the Open Faculty of Humanitas University. Head of the Anaesthesia Unit and Surgical Day Hospital at Humanitas Hospital. E-mail: roberta.monzani@hunimed.it
Objectives	The course aims to provide students with knowledge of the functioning of the human organism in relation to the different stages of life: childhood, adulthood, senescence. By the end of the course, students should know the basic mechanisms that regulate the different organ and system functions. The teaching objective also includes the possibility of providing students with knowledge of particular areas such as paediatric, hyperbaric oxygen therapy and sensory physiology
Teaching methods	Lectures, presentation of audiovisual material and classroom discussions
Teaching material	Slides presented during the lecture, available for physiotherapy students on LMS Fisiologia Umana per le professioni sanitarie, E. Battaglia, R. Amici, Graw Hill Principi di fisiologia per fisioterapisti, Douglas L. Bowell, Edises Compendio di fisiologia umana per i corsi di laurea in professioni sanitarie, M. Midrio et al., Ed Piccin Padova

Content

1) Introduction
General aspects of physiology, definition, composition of the human body when referring to the "standard" and "healthy" subject

2) Physiological changes throughout life
How physiological parameters change in relation to age: from childhood to senescence

3) Sleep
Physiology of sleep-wake rhythm and basic concepts of hypnosis. Physiology of hyperbaric oxygen therapy

4) From cell to tissue
Physiology of chemical, cellular and tissue organisation

5) Sensory physiology
Physiology of the transduction systems of the main senses: hearing, smell, taste, sight and touch

6) Physiology of development and heredity
Mechanisms and stages that lead an organism to reproductive maturity. Physiological characteristics of biological inheritance or inheritance of morphological, physiological,

psychological and possibly pathological characters

7) Paediatric physiology
Physiological differences between children of different ages and the adult.

8) Physiology of the elderly
Physiological differences between the elderly person and the adult with particular reference to the physiology of the neuromuscular system

9) Physiology of the immune and lymphatic systems
Physiology of the immune system: integration of chemical and cellular mediators, structures and biological processes Functional anatomy of the lymphatic system. The thoracic duct and the right lymphatic duct. Lymphatic system and immune function.

10) Physiology of metabolism and nutrition
Physiology of the digestive system and its integration with other systems. Main nutrients and their biological and metabolic value. Physiological significance of basal metabolic rate and work metabolism during physical work.

11) Physiology of the endocrine system
Physiology of the endocrine system. Concept of homeostasis of the organism. The hypothalamic-pituitary axis and hormones: the pituitary gland, the pancreas, the thymus, the thyroid, the parathyroid and the adrenal glands.

12) Body fluid physiology, electrolytes and acid-base balance
Physiological bases of fluids, electrolytes and acid-base balance. Regulation of hydrogen ion concentration. Metabolism of acid-base balance. Elements of pathophysiology of acid-base balance.

13) Physiology of the female and male genital apparatus, menopause and andropause
Functional anatomy of the male and female reproductive system. The menstrual cycle. Biological changes in menopause and andropause.

14) Physiology of the musculoskeletal system
Muscle action potential. Physiology of muscle contraction. The motor unit and neuromuscular activation. Characteristics of different types of muscle and nerve fibres.

15) Physiology of the urinary system
Functional anatomy of kidneys, ureters, bladder and urethra. Nephrons. Blood filtration: glomerular ultrafiltration and urine.

16) Blood physiology
Plasma and specialised cells. Transport of nutrients absorbed in the intestine, oxygen, carbon dioxide, electrolytes, products of catabolism, hormones. Control of body temperature. Control of pH and water balance. Coagulation

17) Physiology of thermoception
Thermoregulation and body temperature. Mechanisms of heat production. Mechanisms of heat

transfer. The thermoregulatory centre.

18) Physiology of alveolar gas exchange
Diffusion of oxygen from the alveoli into the blood and of carbon dioxide in the opposite direction. The diffusion velocity and partial pressure of the gas

19) Cardiovascular physiology
Cardiac output, stroke volume and ejection fraction. Inotropic, chronotropic and dromotropic effect. Cardiac conduction system and cardiac action potential. Principles of haemodynamics.

20) Physiology of the digestive system
Functional anatomy and characteristics of the digestive tract, and associated glands: salivary glands, liver, gallbladder and pancreas. Digestion and absorption.

21) Physiology of pain
Psychophysiological aspects of pain. Peripheral mechanisms involved in nociception. Spinal cord mechanisms involved in nociception. Cerebral mechanisms involved in nociception. Control mechanisms of nociceptor activity.

Lesson 22: Dialogue in the Dark exhibition/trail at the Institute for the Blind in Milan

Lesson 23: Film "The Diving Bell and the Butterfly".

NEUROPHYSIOLOGY (2 ECTS)	
Dr Sara Verpelli	Researcher at the CNR Institute of Neuroscience, Department of Cellular and Molecular Pharmacology. Head of the laboratory "Physiological and pathological mechanisms of synaptic development". E-mail: c.verpelli@in.cnr.it
Dr Francesco Bolzoni	Researcher at the Institute of Physiology, State University of Milan E-mail: francesco.bolzoni@ hunimed.eu
Objectives	Learn the biophysical basis of excitable tissue and the laws governing the conduction and transmission of the nerve impulse. Understand the functions of the central and peripheral nervous system and correlate them with the different anatomical structures. Learn the neurophysiology of motor control.
Teaching methods	Lectures and classroom discussions
Teaching materials	Slides presented during the lecture, available for physiotherapy students on LMS

Content

1) Nerve cells electrical signals
Components of the nervous system: Neurons and glial cells. Organisation of the nervous system and neural circuits. Transmembrane potentials of nerve cells. Channels and transporters.

2) Synaptic transmission
Electrical and chemical synapses. Properties of neurotransmitters. Neurotransmitter release. Role

of calcium in neurotransmitter release. Categories of neurotransmitters. Excitatory synapse Inhibitory synapse

3) Postsynaptic receptors and intracellular signal transduction pathways.
G proteins and second messengers. Short-term synaptic plasticity; long-term synaptic plasticity (LTP and LTD)

4) Somatosensory system and pain
Somatic sensation: pain and heat sensitivity from touch. Mechanoreceptors. The primary somatosensory cortex. Nociceptors. Sensitisation. Physiology of pain modulation

5) Visual function
Eye and central visual pathways. Anatomy of the eye; the retina and retinal circuits. Phototransduction. Cones and rods. Central visual pathways, primary visual cortex.

6) **The auditory system**
The ear, the hair cells and their function. The central auditory pathways. The vestibular system: structure and functions

7) Motor system
Introduction to motor control, general principles of motor system organisation.
The spinal cord, spinal interneurons, spinal reflexes. Stimulation of the peripheral nervous system and H reflex.

8) Postural control
The vestibular system: structure and function. Posture: vestibule, proprioception and vision. Feed-forward postural control: Anticipatory Postural Adjustments.

9) Motor cortex
Corticospinal tract, motor cortex: primary motor cortex, supplementary motor area, premotor cortex. Mirror neurons. Stimulation of the central nervous system.

10) The cerebellum
From the study of cerebellar ataxia to the physiological role of the cerebellum. Functional anatomy of the cerebellum, cerebellar circuits and learning.

11) The basal ganglia and locomotion
Functional anatomy of the basal ganglia. From the study of basal ganglia pathologies to their physiological role. Locomotion: nerve structures involved and biomechanics of locomotion.

EXERCISE PHYSIOLOGY (3 ECTS)	
Dr Marco Ambrosetti	Surgeon, specialised in Cardiology and Internal Medicine. Head of the Rehabilitation Cardiology Unit at the Maugeri Scientific Institute in Pavia. Board member of the Italian Group of Rehabilitation Cardiology and of the Cardiac Rehabilitation Nucleus of the European Association of Preventive Cardiology (EAPC). Lecturer in the Physiotherapy Degree Course at Humanitas University and in the 1st level Master in Rehabilitation and Preventive Cardiology at the University of Pavia.

	E-mail: ambrodoc@gmail.com
Objectives	The aim of the module is to provide knowledge of the integrated metabolic, cardiorespiratory and multi-organ aspects of exercise in the healthy subject. The knowledge acquired lays the foundations for adequate preparation of physiotherapists in terms of functional capacity evaluation and in prescribing, conducting, supervising and evaluating the effectiveness of therapeutic exercise programmes for rehabilitation purposes.
Teaching methods	Lectures with classroom discussion. Practical exercise in electrocardiography, echocardiography and cardiac stress test on healthy subjects by means of audiovisuals. Guided exercise in drawing up a structured physical exercise programme with analysis of basic physiological conditions.
Teaching material	Slides presented during the lecture, available for physiotherapy students on LMS Alloatti G, Antonutto G, et al. Fisiologia dell'uomo. Casa Editrice Edi ermes. McArdle WD, Katch FI, Katch VL. Fisiologia applicata allo sport. Aspetti energetico, nutrizionale e performance. Casa Editrice Ambrosiana.

Content

1) Course introduction

Exercise physiology and taxonomy of physical exercise in the physiotherapy profession. Nutritional aspects of exercise. Definition of physical activity, adapted physical activity, exercise, physical training, physical efficiency. Sedentariness as a cardiovascular risk factor. Core components of exercise physiology knowledge required of the physiotherapist. Physical activity and ICF.

The nutrients underlying physical activity (carbohydrates, lipids, proteins, vitamins, minerals, water).

2) **Energy metabolism and exercise**

Recall of the biochemical basis of muscle energy: energy substrates, oxidative mechanisms, lactacid and alactacid mechanisms.

Bioenergetics and exercise: oxygen debt, steady state, aerobic work, VO2 max, time to exhaustion, anaerobic threshold, maximal aerobic and anaerobic power. Use of different energy substrates (lipids, carbohydrates, phosphocreatine) in relation to the type and intensity of the activity. The respiratory quotient. Basal metabolic rate and energy cost of physical activities.

3) Respiratory system and exercise

Recall of functional anatomy and physiology of the respiratory system: respiratory mechanics, definition of lung volumes and capacities, neural and chemical regulation of respiration.

Respiratory function during exercise: changes in tidal volume and respiratory rate, phases of exercise hyperpnoea. Relationship between ventilation and oxygen consumption in steady state and non-steady state activity. The starting point of lactate accumulation in the blood. Energy cost of breathing during exercise.

4) Gas exchange and exercise. Acid-base regulation and exercise.

Physiology of gas exchange in the lung, oxygen and carbon dioxide transport in the blood. Buffer systems.

Gas exchange during exercise: flow of oxygen and carbon dioxide across the alveolar-capillary barrier during exercise, transport of oxygen and carbon dioxide during exercise. Respiratory and renal regulation of acid-base balance.

5) Cardiovascular system and exercise.

Recall on functional anatomy and physiology of the cardiovascular system: functional anatomy of

the heart and vessels, cardiac mechanics, arterial and venous circulation.
Cardio-circulatory function during exercise: Fick's formula applied to physical activity, changes in cardiac output, stroke volume, blood pressure, heart rate, arterial-venous O2 difference. Behaviour of peripheral resistance. Distribution stroke volume during exercise. Effects of inactivity and exercise on cardiovascular function.
Exercise on analysis/interpretation of cardiac mechanics on dynamic echocardiography (audiovisual in the classroom).

7) Physiology of cardiac impulse propagation and basics of electrocardiography.
Anatomy and physiology of cardiac conduction tissue. Technique for performing and interpreting the basal electrocardiogram in healthy subjects. Introduction to abnormal electrocardiographic pictures. Rationale for the application of baseline ECG and telemetric ECG monitoring in rehabilitation.
Practical exercise: performing and reading ECGs in the classroom.

8) Physical activity and cardiovascular response. Assessment of cardiorespiratory fitness
Classification of physical and sporting activities according to cardiovascular response and haemodynamic response to exercise. Cardiovascular response to constant and intermittent exercise. Energy cost of activities. Classification of exercise intensity levels. Aerobic and anaerobic exercises.
Constant load test protocols: gait analysis. Incremental load test protocols (conventional ergometric test and cardiopulmonary test). Ramp and step test protocols. Concept of maximal and submaximal performance testing. Main parameters assessed by standard ergometric test and cardiopulmonary test: double product, VO2 max, VO2 peak, VO2 at anaerobic threshold and exercise peak, VO2/work-output relationship, oxygen pulse, cardiac power, tidal volume, respiratory rate. Chronotropic reserve and chronotropic competence. Flow-volume curves for the assessment of respiratory mechanics.
Practical exercise: analysis/interpretation of the standard 6-minute walking test report, 12-lead exercise ECG and cardiopulmonary test on a healthy subject (classroom audiovisual).

9) Basics of kinesiology and biomechanics
Tension/length ratio of sarcomere and isolated muscle. Force/speed ratio of the isolated muscle. Static (isometric) and dynamic (isotonic and isokinetic) contractions. Classification of force. Muscle power. Measurement of maximal force. The concept of 1-RM. Muscle fatigue. Fast, slow, intermediate muscle fibres. Muscle hypertrophy and atrophy. Exercise types: continuous endurance, interval endurance, resistance/strength.

10) Physiological principles underlying exercise prescription in the healthy individual
Physiological aspects of the warm-up, activity and cool-down phase. FITT (frequency, intensity, time, type) scheme for prescribing structured exercise. Determination of training load intensity by percentage of HRR and VO2 at peak effort; percentage of HRR and VO2 reserve; HRR and VO2 at ventilatory threshold. Cardiovascular risks and contraindications.
Practical exercise: collaborative development of a structured exercise programme on a healthy subject with focus on the physiological assumptions underlying the prescription steps.

11) Holistic multi-organ vision
Endocrine-metabolic, digestive, haemopoietic, renal-excretory, immune function. Psychological aspects of exercise. Environmental factors: activity at altitude, under thermal stress, in an underwater environment. Review of the essential elements of the course in preparation for the examination.

AUTONOMIC NERVOUS SYSTEM AS A TOOL FOR INTERACTING WITH THE ENVIRONMENT (1 ECTS)	
Prof Raffaello Furlan	Full Professor of Clinical Medicine at Humanitas University. Specialised in Cardiology, Internal Medicine and Sports Medicine. Currently Head of the Unit of Clinical Medicine at Humanitas Hospital. E-mail: raffaello.furlan@hunimed.eu
Objectives	To provide students with a global and concise view of the role of the autonomic nervous system as a tool that enables the individual to relate to his peers and the surrounding environment. The anatomical and functional aspects of this nervous control system will be addressed, in terms of physiology, pathophysiology and neurodegenerative diseases. With regard to neurodegenerative diseases, particular emphasis will be placed on those that are applicable to rehabilitation procedures (Parkinson's disease, Postural Orthostatic Tachycardia Syndrome).
Teaching methods	Lectures with classroom discussion.
Teaching materials	Slides presented during lecture, available for physiotherapy students on LMS Primer on the Autonomic Nervous System, third Edition 2012; D. Robertson, I. Biagioni, G Burnstock, P Low J Patton Editors; ELSEVIER PUBLISHER. Vasovagal Syncope, P Alboni and R Furlan Editors; 2015 Springer Publisher

Content

1) The Autonomic Nervous System in everyday life

Analysis of anatomical aspects of the sympathetic and parasympathetic nervous systems and the baroceptor mechanisms of cardiovascular control. Introduction to the techniques of quantitative study of the autonomic nervous system. Analysis of the functional changes in the autonomic nervous system related to gravitational stimulus, day and night rhythms, physical activity and daily activities.

2) Short- and long-term effects of exercise and repeated physical activity (physical training) on neural control of heart rate

Analysis of the changes in cardiac sympathetic nervous activity, vascular activity, and cardiac parasympathetic activity that make exercise possible. Assessment of the neurovegetative changes that accompany both occasional and recurrent exercise (training). Assessment of the time constants with which these changes occur during training or disappear during de-training. Introduction the concepts of overtraining and overreaching related to physical training.

3) The Autonomic Nervous System in Parkinson's Disease and Dysautonomias

Analysis of the changes in cardiac sympathetic nervous activity, vascular activity, and cardiac parasympathetic activity that accompany Parkinson's disease with and without dysautonomia, and other dysautonomias such as Pure Autonomic Failure. Emphasis on the relationship between impaired functioning of the autonomic nervous system and symptoms complained by these patients. Therapeutic suggestions based on medication and primarily on physical manoeuvres that allow the reduction of orthostatic hypotension and favour motor rehabilitation procedures in these patients.

4) The autonomic nervous system in bed rest and acute and chronic orthostatic intolerance

Assessment of the changes in the neurovegetative and haemodynamic profile that accompany the chronic loss of gravitational stimulus that occurs during prolonged bed rest. Analysis of the

changes obtained with experimental models that simulate the absence of gravity, such as prolonged head-down bed rest at -6°. Discussion on non-pharmacological and pharmacological aids to be used in the bedridden patient, gravitational and then motor reconditioning.

Examination for the Human Physiology course. Written examination with multiple-choice questions on the topics addressed by all modules with the possibility of taking an oral examination as well (Chairman of the Examination Committee: Dr Roberta Monzani).