LIFE OF CELLS, TISSUES AND MICROBES (MZ000002)

1. language

English

2. course contents

Coordinator: Prof. SANGUINETTI MAURIZIO
Year Course: I
Semester: 1st semester
CFU/UFC: 10
Modules and lecturers:
- CELLULAR BIOLOGY 1 (MZ000052) – 3 CFU - SSD BIO/13 Prof. Ornella Parolini, Prof. Andrea Papait
- CELLULAR BIOLOGY PRACTICALS (MZ000053) – 0,50 CFU - SSD BIO/13 Prof. Andrea Papait
- GENERAL MICROBIOLOGY (MZ000054) – 2 CFU - SSD MED/07: Prof. Maurizio Sanguinetti, Prof. Margherita Cacaci
- GENERAL MICROBIOLOGY PRACTICALS (MZ000055) – 0,50 CFU - SSD MED/07: Prof. Ivana Palucci
- GENERAL HISTOLOGY/EMBRIOLOGY (MZ000056) – 2 CFU - SSD BIO/17 Prof. Luca Tamagnone
- GENERAL HISTOLOGY/EMBRIOLOGY PRACTICALS (MZ000057) – 1 CFU - SSD BIO/17 t.b.d.
- PHYSIOLOGY EXCITABLE CELLS (MZ000058) – 1 CFU - SSD BIO/09 Prof. Claudio Grassi

BIBLIOGRAPHY

CELLULAR BIOLOGY I

Karp G, "Cell and Molecular Biology – Concepts and Experiments" 8th edition (or latest available), Wiley, 2016 (or latest available)

For additional consultation: Alberts B, et al. Essential Cell Biology, 5th edition (or latest available), Garland Science - Taylor & Francis Group, 2013 (or latest available).

PHYSIOLOGY OF EXCITABLES CELLS

Walter F. Boron; Emil L. Boulpaep. "Medical Physiology", 2nd Edition Elsevier. ISBN: 978-1-4377-1753-2; ISBN: 978-0-8089-2449-4;

Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, Steven A. Siegelbaum, A. J. Hudspeth "Principles of Neural Science" 5th edition - McGraw-Hill - ISBN: 978-0-07-139011-8

GENERAL MICROBIOLOGY

Madigan MT, et al. "Brock Biology of Microorganisms" 13th edition - Pearson Global Edition.

HISTOLOGY AND GENERAL EMBRYOLOGY

Wojciech Pawlina, "Histology- A Text and Atlas with Correlated Cell and Molecular Biology", 7th or 8th edition, Wolters Kluwer.

- *For additional consultation: Young, B and others - Wheather's Functional Histology, Churchill Livingstone Elsevier, 2013.*

Moore, KL – Persaud, TVN – Torchia, MG. "The Developing Human. Clinically Oriented

Embryology", 9th edition, Elsevier Saunders 2012.
Or, as an alternative: Shoenwolf, GC and others – "Larsen's Human Embryology", Churchill Livingston, 2008.

Additional material (i.e. scientific articles and appropriate electronic sources) will be also provided by the instructors to complete, elaborate and update the contents discussed in each module.

4. LEARNING OBJECTIVES

The whole course is aimed at giving the student a sound understanding of the structures and functions of cells, of the intercellular communications and organization into human tissues, of the basic biology of microorganisms and of their translational relevance.
The course comprises highly integrated teaching modules, having the following specific aims: illustrating the mechanical, morphological and functional properties of cells; describing the mutual interaction occurring between different biomolecules inside the main cell compartments or between cells inside different tissues and organs; describing the basic molecular mechanisms acting inside the cells and mediating their interactions with the external environment; characterizing the interaction between human cells and different microorganisms such as virus and bacteria; describing the basics of cell physiology, with specific regards to the ionic and molecular mechanisms underlying remarkable properties of excitable cells, such as the action potential and synaptic transmission.
At the end of the integrated course the student must demonstrate that he/she has fulfilled the following objectives:

***Knowledge and understanding abilities** – demonstrate the know-how on the different levels of organization of living matter and cellular structures, the main cellular functions and the basic physiological mechanisms, embryo formation, the organization of tissues, and the general concepts of microbiology and of bacterial pathogeny.*

***Applied knowledge and understanding skills** – demonstrate to adequately interpret the importance of knowledge of the mechanisms underlying the organization of higher organisms and their interactions with pathogenic microorganisms, in order to understand the relative applicative implications of the basic biomedical sciences in the diagnostic and therapeutic field.*

***Personal judgement** – the student must properly integrate the knowledge and skills learned to develop autonomous abilities to identify the fundamental structures for the organization of cells and tissues and the associated physiological mechanisms, relevant for the application in the medical field.*

***Communication skills** – be able to communicate scientific and applicative content in a clear and unambiguously way, using an appropriate technical language and explaining their personal conclusions, as well as the knowledge and rationale underlying them, to specialists and non-specialist interlocutors.*

***Learning ability** – be able to keep up-to-date and expand their knowledge by autonomously drawing on scientific texts and articles, and scientific databases (NCBI/PubMed, MedLine, etc).*

5. prerequisites

Knowledge of high school mathematics, chemistry, and biology is recommended, as they are vital for understanding most of the topics taught in the course's modules.

6. TEACHING METHODS

The course is organized into lectures and practical sessions covering the topics included in all the

teaching modules to provide the basic elements of Cell Biology, Electrophysiology, General Microbiology, Histology and Embryology. The teaching methods implement active learning activities, such as problem-based learning, self-learning, case studies, flipped classrooms, and experimental activities.
The adopted teaching methods allow students to pursue the learning objectives:

***Knowledge and understanding** – all the topics listed in the program will be treated during frontal lectures and carefully explained with tutorials and exhaustive explanations, in order to provide the students with the appropriate knowledge and learning methods.*

***Applied knowledge and understanding** – the interactive teaching methods, including "case study", practical examples and laboratory practice exercises, and light microscopy training sessions, will allow students to learn the applicative potential of the treated topics.*

***Making judgements** – the active learning modalities will enable students to independently formulate ideas and use critical reasoning.*

***Communication skills** – the active learning modalities will stimulate active and constant interaction with the instructors, towards the progressive development of focused communication skills for the presentation of treated topics through a correct scientific language.*

***Learning skills** – additional material (i.e. scientific articles and appropriate telematics sources) will support students in their individual and autonomous study.*

Should the instructors deem it necessary, a limited amount of lectures could be performed online in live streaming sessions using the web platform (Blackboard) in use at the Università Cattolica S. Cuore. This may apply to any unpredictable emergency that may prevent the standard teaching delivery methods.

7. OTHER INFORMATIONS

The instructors are available, by appointment besides the classes' timetable, for further clarifications and discussions regarding the learning modules' topics and any possible related issue. Please DO NOT refer to instructors for seeking technical assistance on class attendance or exam registration as they could not help with these issues, which are rather to be checked with the administrative offices.

8. METHODS FOR VERIFYING LEARNING AND FOR EVALUATION

The exam comprises a written examination based on a multiple-choice test regarding all modules; for each question, a single correct answer is possible.
In case of controversial issues, students may be called into a brief oral interview, aimed at validating the results of the multiple-choice questionnaire. The overall and final exam scores will be calculated using a weighted average of the partial scores obtained for the various integrated modules considering the credits assigned to each discipline. The score obtained in the written test will be initially calculated for each of the disciplines for which the threshold was passed, ranging from 18 to 30/30 (or 30 cum laude). The highest grade is assigned to faultless tests.

9. program

< CELLULAR BIOLOGY I>
The concept of biological order applied to living organisms. Prokaryotes and eukaryotes. Autotrophs and heterotrophs. Structure and function of biological molecules. Cell theory and basic properties of cells. General structure of the eukaryotic cell. Structure and function of the plasma membrane. Transport across cell membranes. The extracellular matrix. Cell-cell and cell-extracellular matrix interactions. Structure and function of the mitochondria. Energy metabolism. Structure and function of the endomembrane system: rough endoplasmic reticulum and smooth

endoplasmic reticulum; Golgi apparatus; transport vesicles; lysosomes; peroxisomes. Endocytosis, exocytosis, vesicles transport. The cytoskeleton and its functions: cellular motility, cellular contractility, intracellular transport, the axoneme structure in cilia and flagella, structure and properties of the primary cilium. The nucleus: nuclear envelope, nuclear lamina, nuclear pore complex, nucleolus, DNA assembly into chromatin and chromosomes. The cell cycle and its regulation. Meiosis and mitosis. Cell death mechanisms. INSIGHT: Cellular biology in medicine: stem cells and regenerative medicine.

< CELLULAR BIOLOGY PRACTICALS>

This module is entirely based on laboratory practice exercises to implement selected topics:
1) Cell cycle and its regulation: analysis of microscope slides on mitosis and meiosis;
2) Basic cell culture techniques;
3) in-vitro differentiation assay of mesenchymal stromal cells culture and morphological staining of differentiated cells;

< HISTOLOGY AND GENERAL EMBRYOLOGY>

Histology: *From Cells to Tissues, Organs and Systems. Overview of methods applied for studying differentiated cells and tissues. Introduction to light microscopy and other optical systems; electronic microscopy; atomic force microscopy. Histochemistry and cytochemistry. Immunocytochemistry and hybridization techniques. Organ and tissue cultures. Mechanisms of cell differentiation and histogenesis. Tissue organization and maintenance. Stem cells and their niche. General characteristics of the tissues, their classification and identification. Epithelial tissues: simple and stratified lining epithelia, apical specifications, glandular epithelia. Connective tissues: extracellular matrix, fibers. Adipose tissue. Blood: plasma, red blood cells, leucocytes, platelets. Bone marrow and hematopoiesis. General organization of nerve tissue. Clinical correlations with defects in tissue differentiation and homeostasis.*

General Embryology. *Gametes: features and requirements for fertilization, sperm capacitation, acrosome reaction. Fertilization, molecular events in fertilization. The zygote. Events of the first, second and third week of development and early embryonic differentiation. Blastomeres, morula, compaction, trophoblast and inner cell mass, blastocyst. Embryo implantation in uterus, syncytiotrophoblast differentiation, chorionic villi development. Hypoblast and epiblast, amniotic cavity and yolk sac formation and maturation, extraembryonic mesoderm, blood islands. Gastrulation and formation of the three germ layers (ectoderm, mesoderm, endoderm) and their derivatives: notochord, neural tube and neural crest, somites. Morphogens. Embryo folding, coelomic cavity, primitive gut formation.*

<HISTOLOGY PRACTICALS>

Practical training in the use of light microscope, aimed at providing insights for a better understanding of histological aspects illustrated during lessons, as well as the acquisition of a professional competence for the analysis of tissue and cell samples of medical relevance. In particular, it will be given an overview of main histological methods applied in research and clinical fields, with focus on specimen preparation and stainings used to study different tissues, cells, and subcellular elements. By the examination of diverse specimens (such as: skin, trachea, lung, small intestine, blood smear, etc.), the students will be guided to understand the typical features and organization of epithelial and connective tissues in the context of different organs, identify blood components, and correlate structure with function, at cellular and tissue level.

<GENERAL MICROBIOLOGY *>*

Introduction to the microbial world through an historical perspective. Bacterial cell structure and functions. Specialized structures (peptidoglycan, flagella, pili, endospores). Bacterial growth, replication and survival; general concepts on bacterial metabolism; Bacterial targets of antibiotics and immunity; Fungi: general features on structure and function; classification; Protozoa: general features on structure and function; classification; Viruses: general features on structure and function; replication and cultivation; classification; molecular targets of antiviral agents; Phages: biology and applications. Bacterial genetics; Recombination, horizontal gene transfer and sources of genetic variability. The plasticity of bacterial genomes; Microbes, evolution and the tree of life. The human microbiota; general concepts in bacterial pathogenesis.

<GENERAL MICROBIOLOGY PRACTICALS>

Preparation of media and agar plates; Culturing, counting and detecting bacteria; The skin microbiota: assessing activity of hand disinfectants; Gram staining and microscopical analysis of bacteria; Microscopical analysis of biological samples; Microscopical analysis of fungi.

<PHYSIOLOGY OF EXCITABLE CELLS>

Ionic channels and transporters. Resting membrane potential. Local electrical signal: passive electrical proprieties of excitable cells. Voltage-dependent membrane permeability. Propagated electrical signals: the action potential. Synaptic transmission: overview, neurotransmitters, neurotransmitter release, receptors and neurotransmitter transporters, postsynaptic potentials, synaptic integration Molecular signaling within the neurons. Neuromuscular junction.

<PHYSIOLOGY OF EXCITABLE CELLS PRACTICALS>
Practical class aim to provide a thorough understanding of the neuronal function by using both a virtual laboratory and allowing students to participate to a real experiment in the electrophysiology laboratory. In particular, with software students will be guided to understand the function of ion channels and currents involved in generation of action potentials, as well as the passive properties of the neuronal membrane. In the laboratory, students will learn how to record the functional properties of synapses, i.e., the basal synaptic transmission and plasticity. Moreover, this practical will give an overview of the principal electrophysiological techniques applied in neurophysiology research.