

Biomedical sciences i

Integrated course

1. language

Inglese / English

2. course contents

Coordinatore/Coordinator: Prof. Wanda Lattanzi

Anno di corso/Year Course: 1

Semestre/Semester: 2

CFU/UFC: 12

Moduli e docenti incaricati /Modules and lecturers:

Cellular biology I (3 UFC): Wanda Lattanzi / Lorena Di Pietro

Cellular biology I practicals (1 UFC): Marta Barba/Saccone Valentina / Palacios Daniela /Lorena Di Pietro

Physiology of excitable cells (0.8 UFC): Marcello D'Ascenzo

Physiology of excitable cells practicals (0.2 UFC): Cristian Ripoli

General microbiology (2 UFC): Giovanni Delogu

General microbiology practicals (1 UFC): Giovanni Delogu /Michela Sali

Histology and general embryology (2.2 UFC): Luca Tamagnone

Histology and general embryology practicals (1.8 UFC): Maria Teresa Viscomi / Silvia Masciarelli

3. bibliography

CELLULAR BIOLOGY I

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

For additional consultation: Alberts B, et al. *Essential Cell Biology*, 4th Edition, Garland Science - Taylor & Francis Group, 2013.

PHYSIOLOGY OF EXCITABLE CELLS

Medical Physiology Author: Walter F. Boron; Emil L. Boulpaep Elsevier (Second Edition) ISBN: 978-1-4377-1753-2; ISBN: 978-0-8089-2449-4;

Principles of Neural Science Author: Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, Steven A. Siegelbaum, A. J. Hudspeth McGraw-Hill (Fifth Edition) ISBN: 978-0-07-139011-8

GENERAL MICROBIOLOGY

Madigan MT, et al. *Brock Biology of Microorganisms* 13th edition. Material provided by the teacher. 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 Livingstone, 2008.

Additional material will be provided (i.e. scientific articles and appropriate telematic sources) 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, 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

In order to better understand the topics of the course and to formally register for the exam session,

students must have attended and passed the exam of Basic Sciences.

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 and experimental activities.

The adopted teaching methods allow students to pursue the learning objectives:

Knowledge and understanding abilities – 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 skills – the interactive teaching methods, including “case study”, practical examples and laboratory practice exercises, will allow students to learn the applicative potential of the treated topics.

Personal judgement – 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 ability – additional material (i.e. scientific articles and appropriate telematic sources) will support students in their individual and autonomous study.

WARNING: *should the emergency related to the COVID-19 pandemic outbreak persist requiring online teaching, lectures will be performed during live streaming sessions using the web platform (Blackboard) in use at the Università Cattolica S. Cuore.*

In particular, when needed, the practicals' activities will also implement virtual laboratory sessions (using web-based tools such as JoVE) for the Cellular Biology I part, and guided analysis of representative histological images for the Histology part.

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.

8. methods for verifying learning and for evaluation

The exam is composed of a written test comprising 50 multiple-choice quizzes divided into 2 blocks:

- 1. Biology (17 quizzes) and General Microbiology (12 quizzes)*
- 2. Histology and general embryology (16 quizzes) and physiology (5 quizzes).*

For each quiz a single correct answer is possible. Each correct answer correspond to a score= 1,

wrong/no answer correspond to score= 0. To pass the written test the student needs to answer correctly to at least 15 quizzes in module 1 and 11 quizzes in module 2. The score obtained in the written test is calculated according to the following scale:

26/50 = 18

27/50 = 18

28/50 =19

29/50 =19

30/50 =20

31/50 =20

32/50 =21

33/50 =21

34/50 =22

35/50 =22

36/50 =23

37/50 =23

38/50 =24

39/50 =24

40/50 =25

41/50 =25

42/50 = 26

43/50 =26

44/50 = 27

45/50 = 27

46/50 =28

47/50 = 28

48/50 = 29

49/50 = 30

50/50 =30 with honors

The minimum score that needs to be achieved to pass the written test is 18. Passing the written test will give access to a brief oral examination, including a practical test on histological slide examination. During the oral test the students will be asked an overall number of 4 questions, each scoring in the -1/+1 range. The final score achieved in the oral part will be then -4/+4 and will be added to the score achieved in the written test to calculate the final score. The student will be able to obtain the maximum final score (30/30 with honors) only if he/she achieved a minimum score of 27/30 in the written part.

The objective of the evaluation system is to verify:

- the knowledge and understanding of the different levels of organization of living matter and cellular structures, the main cellular functions and the basic physiological mechanisms, the organization of tissues and the general concepts of the microbial world and of microbial pathogenesis (knowledge and understanding);

- the ability to connect theoretical concepts and practical problems regarding the different aspects discussed during the course (Applied knowledge and understanding);

- the ability to integrate the themes treated in the different modules of the course (Personal judgement);

- the development of communication skills for the presentation of treated topics through a correct scientific language (Communication skills);

- the ability to autonomously delve into specific biomedical topics (Learning ability).

WARNING: should the emergency related to the COVID-19 pandemic outbreak persist requiring online evaluations, these will be performed using the web platform (Blackboard, Microsoft Teams) in use at the Università Cattolica S. Cuore.

The concept of biological order applied to living organisms.

Prokaryotes and eukaryotes.

Structure and function of biological molecules.

Autotrophs and heterotrophs.

Cell theory and basic properties of cells.

General structure of the eukaryotic cell.

Structure and function of the plasma membrane.

Transport across cell membranes.

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, lysosomes, peroxisomes.

Endocytosis, exocytosis, vesicles transport.

The cytoskeleton and its functions: cellular motility, cellular contractility, intracellular transport.

The nucleus: nuclear membrane, nucleolus, chromosomes, genes and genomic organization.

The cell cycle and its regulation. Meiosis and mitosis.

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;*
- 4) Nucleic Acid isolation.*

PHYSIOLOGY OF EXCITABLE CELLS

Ionic channels and transporters

Resting membrane potential

Local electrical signal: passive electrical properties 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:

Practicals 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.

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.

HISTOLOGY AND GENERAL EMBRYOLOGY

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 cell differentiation and histogenesis. Tissue organization and maintenance. Stem cells and their niche. General characteristics of the tissues, their classification and identification. Epithelial tissue. Connective tissue. Adipose tissue. Blood. Hematopoiesis. Bone marrow. General organization of nerve tissue. Clinical correlations with defects in tissue differentiation and homeostasis. General Embryology. Sperm capacitation. Acrosome reaction. Fertilization. Molecular events in fertilization. The zygote. Early stages of segmentation and early differentiation events. Events of the first, second and third week of development. Formation of the three germ layers and their derivatives. Morphogens.

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.