CELLULAR BIOTEChNOLOGIES (A000207)

Integrated multi-modular course

1. language

Italian.

2. course contents

Coordinator: Prof. PAROLINI ORNELLA

Academic Year: 2022/2023

Year Course: 1st Year

Semester: 1st

UFC (university credits): 8

Modules and lecturers:
- STEM CELLS AND THEIR APPLICATIONS (A000223) - 4 UFC - SSD BIO/13
Proff. Ornella Parolini, Prof. Wanda Lattanzi

- CELL DIFFERENTIATION AND TISSUE MORPHOGENESIS (A000224) - 2 UFC - SSD BIO/17
Prof. Fortunata Iacopino

- CHARACTERIZATION AND FUNCTIONS OF THE MICROBIOTA (A000225) - 2 UFC - SSD MED/07

Prof. Maurizio Sanguinetti

3. bibliography

STEM CELLS AND THEIR APPLICATIONS

The following textbooks may be used for consultation on basic topics:

- Cellule staminali. G.P. Bagnara, L. Bonsi e F. Alviano. Seconda edizione – 2017. Ed. Esculapio.

- Stem cells: an insider's guide. P. Knoepfler. 1st edition – 2013. Ed. World Scientific.

- Essentials of Stem Cell Biology. R. Lanza, A. Atala. 3rd edtion – 2013. Ed. Academic Press.

- The Science of Stem Cells. J.M.W. Slack. Ed. 2018 Wiley

Updated references from scientific publications will be suggested and provided by the instructors during their lectures.

CELL DIFFERENTIATION AND TISSUE MORPHOGENESIS

- Embriologia Umana – AA.VV. – Piccin, 2016

CHARACTERIZATION AND FUNCTIONS OF THE - MICROBIOTA

- Gut microbiota: Interactive Effects on Nutrition and Health. E. Ishiguro, N. Haskey, K. Campbell. Ed. Academic Press

- Microbiota of the human body: implications in health and disease. A. Schwiertz Ed. Springer

Updated references from scientific publications will be suggested and provided by the instructors during their lectures.

4. learning objectives

The integrated course aims to deepen the specialized knowledge of topics pertaining to advanced cellular biotechnology, ranging from the characterization and application potential of somatic stem cells in human tissues, to the molecular mechanisms underlying differentiation and morphogenesis in the embryonic period, to the study of the characteristics and properties of microbial communities in the human body, with special emphasis on the gut microbiota.

Upon completion of the integrated course, the student must demonstrate that he/she has acquired the following objectives:

***Knowledge and understanding** of modern biotechnologies for the study of cells and tissues, with particular reference to somatic stem cells, their characterization, and their implication in histo-morphogenesis and homeostasis of human organs and tissues. The course will provide the student with an integrated approach (genomic, bioinformatics, and clinical) for an effective understanding of the biological processes of microbial communities residing in the human body and their impact on the pathogenesis and development of various human diseases.*

***Applying knowledge and understanding** - to know how to properly interpret and understand the application implications of Cellular Biotechnology highlighting: the translational potential of stem cells in regenerative medicine applications and in disease models; the role of the interaction of microbial communities with the human ecosystem, as well as procedures for manipulating the microbiota to contribute to the treatment of various human diseases.*

***Making judgements** to integrate the knowledge and skills learned to identify the most appropriate Cellular Biotechnologies to be used in the development of innovative therapeutic protocols for personalized medicine.*

***Communication skills** to know how to communicate clearly and unambiguously, using technical language correctly, for disseminating scientific content pertaining to the morphological and functional characteristics of stem cells and the human microbiota, to specialist and non-specialist audiences.*

***Learning skills** to update and expand his/her knowledge from texts, scientific articles and online platforms (NCBI, ATCC, Human cell atlas etc.). He/she must gradually acquire the ability to attend specialized seminars, conferences, master's degrees etc.*

5. PREREQUISITES

Students must have previously acquired knowledge related to the basic disciplines provided in the three-year degree courses preparatory to this degree class, with particular reference to: cellular/molecular experimental Biology, Microbiology and Histology.

6. teaching methods

The teaching methodology is based on face-to-face lectures delivered by providing both the basic elements of the various disciplines and application perspectives. Lectures are based on interactive modes, supplementing standard teaching with activities marked by active learning, such as: "problem-based learning," "self-learning," and "case studies."

The teaching methods used in this course are designed to enable the student to pursue the learning objectives, by virtue of the following characteristics:

***Knowledge and understanding** - frontal teaching will systematically cover all the topics listed in the program detailed below, dwelling on the most relevant and indispensable aspects, so as to provide students with the complete picture of the integrated topics and the correct study method to reinforce theoretical knowledge.*

***Applying knowledge and understanding** - the use of practical examples, classroom exercises and "case studies" enables students to learn the application potential of the topics covered.*

***Making judgements** - the active learning methods implemented in this course are designed to allow the student the ability to formulate concepts and ideas independently.*

***Communication skills** - active learning methods and constant interaction with the instructor during lectures will be conducted in a manner that will allow the student the progressive acquisition of communication skills aimed at the exposition of applied biology topics with the correct scientific terminology.*

***Learning skills** - the use of supplementary teaching materials, including in the form of articles from the international scientific literature, will enable the student to continue to study mostly self-directed or independently.*

Where the continuation of the COVID-19 emergency makes it necessary to impart distance learning activities, the course will be conducted via live streaming sessions on the telematic platforms available in the university (Microsoft Teams and Blackboard).

7. other information

Lecturers are available for reception by appointment after contacting them by email:

Ornella Parolini: *ornella.parolini@unicatt.it*

Wanda Lattanzi: *Wanda.Lattanzi@unicatt.it*

Fortunata Iacopino: *Fortunata.Iacopino@unicatt.it*

Maurizio Sanguinetti: *Maurizio.Sanguinetti@unicatt.it*

Lecturers may send communications to the class via email and/or via the BlackBoard platform.

8. methods for learning evaluation

The examination consists of an oral test with questions pertaining to the content of all course modules (the number of questions given is proportional to the number of CFUs for each module). To pass the examination, the student must answer correctly and thoroughly at least one question for each teaching module. The student will be able to achieve the maximum score (30/30 cum

laude) by answering correctly, completely and exhaustively all questions from all teaching modules, demonstrating critical and integration skills of the content learned.

The objective of the examination thus organized is to assess the student's acquisition of the following skills and knowledge:

***Knowledge and understanding** of the topics covered in the program and of the role of the cellular and molecular processes studied;*

***Applying knowledge and understanding** that is the ability to connect theoretical concepts of applied biology to the pharmaceutical field, with reference to the mechanisms of biological action of drugs and the possible applications of cellular properties in the development of modern drug therapies;*

***Making judgements** showing the ability to make cross-cutting connections on the topics covered;*

***Communication skills** by showing the adequate mastery of language and correct technical/scientific terminology;*

***Learning skills** , through the ability to investigate topics of biological interest independently and to use critical reasoning.*

Where the continuation of the COVID-19 emergency makes it necessary to conduct teaching activities remotely, learning assessments will be based on distance interview through use of telematics platforms available in the university (Microsoft Teams and Blackboard).

9. program

< STEM CELLS AND THEIR APPLICATIONS >

Generalities, classifications and historical background on stem cells. Stem cell properties: asymmetric division and cell cycle, morphological and functional aspects, molecular basis of stemness. Differential potentiality and plasticity of stem cells: totipotency, pluripotency, multipotency. Molecular bases of differentiative plasticity. Embryonic stem cells vs somatic stem cells. Main tissue sources of somatic stem cells: perinatal sources (placenta, umbilical cord), postnatal adult tissues (bone marrow, adipose tissue). Biological properties of hematopoietic stem cells and mesenchymal stromal cells. Characteristics and homeostatic mechanisms of stem cell niches. Stem cell secretome and paracrine mechanisms. Stromal stem cells and immuno-modulation. Placental stem cells and their derivatives, biological properties and mention of applications in immune-mediated and inflammatory diseases. Introduction to ex vivo isolation and expansion methods of hematopoietic and mesenchymal stromal stem cells. Induced pluripotent cells (iPSCs), hints on production protocols and experimental applications.

< CELL DIFFERENTIATION AND TISSUE MORPHOGENESIS >

Molecular mechanisms underlying the regulation of cell differentiation, with emphasis on processes responsible for embryonic development, morphogenesis, and regeneration processes in different tissues.

The control of cell proliferation, apoptosis and differentiation. Extracellular factors and their receptors. Signal transduction pathways and control of gene transcription. Juxtacrine/paracrine signals affecting the tissue microenvironment.

Embryonic Tissue Differentiation: Induction, Determination, and Genetic and Epigenetic Factors Involved in the Control of These Processes. Morphogenesis and Morphogenetic Factors.

Molecular mechanisms underlying: 1) Fertilization and Zygote formation; 2) Morula compaction and blastocyst formation; Blastomere differentiation into trophoblast and inner cell mass; 3) Trophoblast differentiation; 4) Extraembryonic Mesoderm formation, vasculogenesis and neoangiogenesis; 5) Gastrulation: Epithelial-mesenchymal transition; 6) Nottochord and body axis definition, embryo folding; 7) Neurulation and Somitogenesis.

< CHARACTERIZATION AND FUNCTIONS OF THE MICROBIOTA >

Introduction to metagenomics: fundamentals and terminology.

Methodologies used to study complex microbial populations: from clinical sample to metagenomic map.

Study of the biodiversity of complex microbial communities.

The gut, oral, vaginal and skin microbiota in humans.

Human gut microbiota and dysbiosis: the Anna Karenina principle.

Impact and role of the microbiota in the genesis of infectious diseases in humans.

Impact and role of the microbiota in the genesis of human chronic inflammatory diseases, intestinal and extra intestinal.

Impact and role of the microbiota in the genesis of human respiratory diseases, both acute and chronic.

Impact and role of microbiota in metabolic syndromes and diabetes.

Methods of microbiota transplantation and its role in the treatment of human diseases.

Probiotic bacteria and prebiotic substances.