UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Fundamentals of Biology

**2021-1-E0201Q047**

## Aims

The course aims to provide the student with the basic knowledge of the eukaryotic cell from a morpho-functional and ultrastructural point of view, the structural and functional properties of differentiated animal cells and their association modalities in tissue formation. Furthermore, a part of the course aims to provide the basics on the mechanisms of biological evolution. The lectures are complemented by the mandatory laboratory activity in which the use of the optical microscope will allow to observe histological preparations in order to acquire skills in the recognition of different tissues and their associations in relation to the functions of the tissues themselves.

Knowledge and understanding.

At the end of the course the student will know the correlations between the molecular, cellular, tissue and organ levels in animal biology; will gain the knowledge of the structure and function of the components of the eukaryotic cell and animal tissues and the basic use of the optical microscope; will know the biological bases and the main mechanisms of evolution; will be able to understand the biological terminology related to these disciplines.

Applying knowledge and comprehension

At the end of the course the student will gain the ability to apply the knowledge acquired in point 1 to recognize cellular organelles in electron microscopy images; will be able to use an optical microscope and recognize the main tissues; will be able to understand the information obtained from two-dimensional images to reconstruct three-dimensional structures.

Making judgments

At the end of the course the student will be able to choose the appropriate method for analyzing cell and tissues;

will be able to identify the incontrovertible aspects of evolution; will gain the ability to identify the key concepts, summarize and exemplify them; will be able to know how to use the textbook and virtual resources in an informed way to develop insights.

Communication skills

At the end of the course, the student will have developed the ability to describe and represent the morpho-functional aspects of cells and tissues in a clear and rigorous way by appropriately using biological terminology.

Learning skills

At the end of the course the student will be able to consult the literature on the topics covered; will be able to analyze, apply, integrate and connect the knowledge acquired with what will be learned in the subsequent courses of the study plan.

## Contents

Cytology:
1. Introduction to the study of cytology
2. The chemical basis of living matter
3. The plasma membrane
4. The cytoplasm
5. The nucleus
Elements of Biological Evolution
Laboratory: Elements of Histology
1. Epithelial tissues
2. Proper and specialized connective tissues
3. Muscle tissues
4. Nervous tissue

## Detailed program

Cytology
1-Introduction to the study of cytology
Hierarchy and complexity of biological organization. The cell as a fundamental unit of living organisms. Morphology and general organization of the prokaryotic cell and of the animal and plant eukaryotic cell. Orders of magnitude, units of measurement and resolution limits. Microscopic techniques for the study of cells and tissues.
2-The chemical basis of living matter
Structure and function of biological macromolecules (sugars, lipids, proteins, nucleic acids).
3-The plasma membrane
Properties and functions. Molecular composition and architecture: the fluid mosaic and lipid raft model; permeability and membrane transport mechanisms: simple diffusion, osmosis, passive and active transport, carrier proteins and membrane pumps, ion channels, membrane potential. Receptors, cell-to-cell communication and signal

transduction. Specialization of the plasma membrane: microvilli, cilia and flagella, glycocalyx, cellular junctions (tight, adherent, desmosomes and communicating), extracellular matrix and cell-matrix interactions (focal contacts and hemidesmosomes).
4-The cytoplasm
Composition of the cytosol, ribosomes and polyribosomes. Endomembrane system and compartmentalization in eukaryotic cells: rough and smooth endoplasmic reticulum, Golgi apparatus, vesicular trafficking and protein coatings, lysosomes, endocytosis and exocytosis. Peroxisomes, mitochondria and chloroplasts. The cytoskeleton: structure and function of microtubules, centrosome and MTOC, model of dynamic instability, microtubular motors, ultrastructure of the axonema in cilia and flagella; structure and function of microfilaments, assembly and disassembly, interactions of actin filaments with myosin and actin-binding proteins in muscle and non-muscle cells; structure and function of intermediate filaments. Relationship between cytoskeleton and other cellular structures.
5-The nucleus
Structure of the interphase nucleus. Nuclear envelope and nuclear pores. Exchanges between nucleus and cytoplasm. Nucleolus. Chromatin structure. Constitutive and facultative heterochromatin. Metaphasic chromosomes and karyotype. Notes on the structure and function of the main RNAs. Genetic code. Introduction to DNA duplication, transcription and translation of genetic information. The cell cycle phases. Phase M: mitosis and cytokinesis. Sexual reproduction: somatic cells and germ cells. Meiosis, gametogenesis and gamete structure.
Principles of Biological Evolution
Panorama of living forms. Systematic categories. Genotype, phenotype, fitness, natural and artificial selection. Analogy and homology. Coevolution, mimetism. Hardy-Weinberg's principle. Mutations, genetic drift. Evolutionary meaning of sexual reproduction. Speciation. Molecular evolution. The historical evidence of evolution. Lamarckism, Darwinism, neo-Darwinism. Gradualism and punctuated equilibrium.

Laboratory: histology
1-Epithelial tissues
Structural and functional classification of epithelia, morpho-functional polarity of epithelial cells; basement membrane. Coating epithelia. Glandular epithelia.
2-Connective tissues proper and specialized
Connective tissues proper: Own and migrating cells; extracellular matrix: biosynthesis and organization of extracellular components. Functions. Loose and dense fibrous connective tissue, reticular, elastic and adipose tissues. Supportive connective tissues: cartilage; spongy and compact bone tissue: mechanical functions and metabolic homeostasis, ossification. bone growth and rehash. Blood: Plasma and figurative elements.
3-Muscle tissues
Skeletal striated muscle tissue: histological organization, ultrastructural bases of muscle contraction. Cardiac striated muscle tissue: structural and ultrastructural organization, intercalary discs. Smooth muscle tissue: histological organization, distribution and functions.
4-Nervous tissue
General organization of the nervous system. Neuron structure and glia cells.

## Prerequisites

Background: basic knowledge of biology acquired in secondary school.
Prerequisites: none

## Teaching form

Classroom lectures supported by PowerPoint slides (56 h, 7 ECTS) and laboratory practicals (10 h, 1 ECTS). Laboratory practicals introduce students to the use of the optical microscope, for the observation and recognition of histological preparations.

Teaching language: italian.

During the Covid-19 emergency, lectures will be given to relatively small and separate groups of students. These groups will attend for an entire week and the groups will be flipped between weeks. All lessons will be recorded and made available through the e-learning platform.

The laboratory experiences during the emergency will be reduced in number and replaced with remote activities, made available through e-learning platform.

## Textbook and teaching resource

Learning material (slides of the lessons and scientific videos) wil be available at the e-learning platform of the course.

Recommended textbooks.
Students can choose among the following options:
- Citologia e Istologia. I. Dalle Donne, S. Beninati, P. Bonfanti et al. EdiSES 2019
- Biologia cellulare e molecolare. Concetti ed esperimenti. G. Karp. EdiSes and Istologia ed elementi di anatomia microscopica - Dalle Donne et al., EdiSES. II edizione
- L'essenziale di biologia molecolare della cellula. Alberts B., et al. Zanichelli and Istologia ed elementi di anatomia microscopica - Dalle Donne et al., EdiSES. II edizione

For Evolution topics: Biologia Evoluzionistica e biodiversità. S.L. Wolfe et al. Ed. EdiSEs

## Semester

First semester

## Assessment method

During Covid-19 emergency there will be oral examination through web resources only.

In Moodle e-learning will be published the open link to assist to the session (without interactions). Exam attendee will have a dedicated access.

Examination in normal conditions:

The examination consists of a written test with closed questions (true/false type, choice and multiple choice and completion) and an oral examination. The written test is aimed at verifying the knowledge of the terminology and the basic concepts of the topics covered while the oral examination focuses on the more conceptual aspects of the course contents, with the aim of verifying the abilities of re-elaboration, connection between the different topics covered, the clarity of exposition and the property of language. Access to the oral examination is expected only

after passing the written test with a mark expressed in thirtieths equal to 18. The final grade of the examination expressed in thirtieths will not derive from the arithmetic average of the grades of the written and oral exam, but greater weight will be given to the oral examination. The oral examination will be carried out in the days following the written test according to a calendar published on the moodle page of the course together with the results of the written examination.

## Office hours

Contact: on demand, upon request by mail to lecturer