



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Fundamentals of Biology

2425-1-E0201Q047

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#### 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. The teaching also includes hints on the mechanisms of biological evolution as a unifying theory of biology.

The lectures are complemented by 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.

The goals to be achieved are:

#### **1-Knowledge and understanding.**

At the end of the course the student will have to know the relationships between the molecular, cellular, tissue and organological levels in animal biology; must know the structure and function of the components of the eukaryotic cell and animal tissues and the basic use of the optical microscope; he will have to know the biological basis and the main mechanisms of evolution; must be able to understand the biological terminology related to these disciplines.

#### **2-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.

#### **3-Making judgments**

At the end of the course the student will have to prove autonomous in the choice of the criteria and the appropriate method for the analysis of specific structural aspects of the cell and of the tissues; he will have to identify the incontrovertible aspects of evolution; must be able to identify key concepts in cell biology, synthesize and exemplify them; will be able to consciously use the textbook and virtual resources to develop insights independently.

#### **4-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.

#### **5-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

### **Tutorial Activities: Principles 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.

### **Tutorial activities: Principles of Histology**

#### *1-Epithelial tissues*

Structural and functional classification of epithelia, morpho-functional polarity of epithelial cells; basement membrane. Coating epithelia. Glandular epithelia.

#### *2-Proper and specialized connective tissues \**

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*

Elements of 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**

### **28 2 hours-lectures composed by:**

- a section of delivered didactics (Didattica erogativa, DE) focused on the presentation-illustration of contents by the lecturer.
- a section of interactive teaching (Didattica Interattiva, DI) including teaching interventions supplementary to delivered didactic activities, short interventions by trainees, demonstrations, practical applications and short itinere tests not subject to assessment aimed at personal verification of learning.

Didactic activities are conveyed by means of **face-to-face lectures**.

**5 2 hours-Tutorial activities** aimed at guiding in the use of the optical microscope for the observation and recognition of histological slides, delivered by interactive teaching (Didattica Interattiva, DI) through **in person tutorials**.

Teaching language: Italian.

## **Textbook and teaching resource**

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

The video recordings of the frontal lessons will be provided, accessible in asynchronous mode as a support for studying.

Self-assessment test provided by the textbook publishers will also be made available on the course's e-learning page.

### **Recommended textbooks equipped with digital resources supplied by the editors.**

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
- Beker: Il mondo della cellula - 10Ed. - Hardin, Lodolce- Pearson 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**

Written test with compulsory oral examination.

The written test is aimed at the extensive check of the preparation on the exam program, verifying knowledge of specific terminology, basic concepts of the topics covered in teaching, and the ability to recognize tissues in images of histological preparations. It is carried out through the moodle exam platform and is made up of closed questions (Types: True/false, Correspondences, Multiple Choice, Multiple Answer, Completion).

The oral exam consists of an interview on the topics covered in class, aimed at verifying the ability to rework information, connect different topics, clarity of exposition, and language propriety. 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 ([patrizia.bonfanti@unimib.it](mailto:patrizia.bonfanti@unimib.it))

## **Sustainable Development Goals**

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | LIFE ON LAND

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