I. OVERVIEW

Subject area	Cellular Biology
Degree	Medicine
School/Faculty	School of Biomedical and Health Sciences
Year	1
ECTS	6
Type	Core
Language	Spanish
Delivery Mode	On campus
Semester	1

2. INTRODUCTION

Knowledge of cellular biology is essential to understanding the organism and the physical nature of diseases. This subject aims to provide students with detailed understanding of the structure and function of cells and how they contribute to the way the human body works. Students will gain an all-encompassing perspective of this subject area. This is the most basic understanding of living beings and is key to understanding the organisation and physiology on more complex levels (tissue, organs and systems, etc.). We also aim to familiarise students with the study methods commonly used in this area.

The content covered in the course is summarised in section 4 of this guide. There is also an index of subject topics which shows how they are organised into content units.

3. SKILLS AND LEARNING OUTCOMES

Key skills (CB, by the acronym in Spanish):

- **CB1:** Students have demonstrated possession and understanding of knowledge in a study area that builds on general secondary education, and is typically at a level that, while supported by advanced textbooks, also includes aspects that involve knowledge from the forefront of their field of study.

- **CB5:** Students have developed the learning skills necessary to undertake further study in a much more independent manner.

General skills (CG, by the acronym in Spanish):

• **CG.7.** Understand and recognise the normal structure and function of the human body. This includes studies of molecules, cells, tissue, organs and systems in the different stages of life.

• **CG11.** Understand and recognise the effects of growth, development and ageing on the individual and the social environment.

Cross-curricular skills (CT, by the acronym in Spanish):

• **CT3:** Teamwork: ability to integrate and collaborate actively with other people, areas and/or

organisations to reach common goals, evaluate and integrate contributions from the rest of the group members and create a good working environment.

• **CT6:** Problem solving: ability to solve an unclear or complex issue or situation which has no established solution and requires skill to reach a conclusion.

• **CT8:** Planning and organization: ability to set objectives and choose the right means to fulfil them through the efficient use of time and resources.

• **CT10:** Independent learning: the ability to govern your own development by choosing the most effective lines of action, strategies, tools and opportunities to independently learn and apply knowledge to practice.

Specific skills (CE, by the acronym in Spanish):

• **CE 1.1.1:** Recognising the structure and function of cells. Biomolecules. Metabolism. Metabolic regulation and integration.

• **CE 1.1.2:** Understanding the fundamentals of human nutrition. Cell communication. Excitable membranes. The Cell Cycle. Cellular differentiation and proliferation. Gene expression, information and regulation. Heredity. Embryo development and organogenesis.

• **CE 1.2.2:** Using basic laboratory techniques and materials. Interpreting a normal analysis. Using macroscopic, microscopic and imaging techniques to recognise the morphology and structure of tissue, organs and systems. Performing functional tests and determining vital signs and how to interpret them. The basic physical examination.

Learning outcomes (RA, by the acronym in Spanish):

• Understand the normal structure and function of eukaryotic cells and their role as a basic unit of all structures in living beings.

• Describe the relationships between cells and their environment.

• Understand the different membrane transport mechanisms and their importance to cellular physiology.

• Understand the mechanisms of cell division, what makes up the cell cycle and control mechanisms.

• Establish the general characteristics of gametogenesis and fertilisation.

• Understand the cleavage, the blastula stage and gastrulation of the human embryo.

• Recognise the mechanisms of ectodermal, mesodermal and endodermal development and establish their relationship with organ growth in humans.

• Understand the effects of ageing on the structure and function of cells and understand the concept of apoptosis.

• Know what stem cells are and their main characteristics.

• Understand the concept of cellular differentiation and its role in the appearance of different types of cells.

• Understand the main alterations in the normal structure and function of cells and their relationship with the appearance of different types of pathologies.

- Understand the function of each of the components of a optical microscope.
- Know how to use the optical microscope and recognise the different types of cells and their basic cell components.
- Recognise and interpret the different phases of mitosis under the optical microscope.
- Recognise and interpret the most important cell structures in electronic micrograph images.
- Understand and experience the main basic laboratory techniques.

The following table shows how the skills developed in the course match up with the intended learning outcomes:

Skills	Learning outcomes
CB1, CB5, CG7, CT8, CT10, CE1.1.1.	- Understand the normal structure and function of eukaryotic cells and their role as a basic unit of all structures in living beings. - Describe the relationships between cells and their environment. - Understand the different membrane transport mechanisms and their importance to cellular physiology.
CB1, CB5, CG7, CT8, CT10, CE1.1.1., CE1.1.2.	- Understand the mechanisms of cell division, what makes up the cell cycle and control mechanisms.
CB1, CB5, CG7, CG11, CT8, CT10, CE1.1.1., CE1.1.2.	- Establish the general characteristics of gametogenesis and fertilisation. - Understand the cleavage, the blastula stage and gastrulation of the human embryo. - Recognise the mechanisms of ectodermal, mesodermal and endodermal development and establish their relationship with organ growth in humans. - Understand the effects of ageing on the structure and function of cells and understand the concept of apoptosis. - Know what stem cells are and their main characteristics - Understand the concept of cellular differentiation and its role in the appearance of different types of cells.
CB1, CB5, CG7, CT3, CT6, CT8, CT10, CE1.1.1.	- Understand the main alterations in the normal structure and function of cells and their relationship with the appearance of different types of pathologies.
CB1, CB5, CT3, CT8, CT10, CE1.2.2.	- Understand the function of each of the components of a optical microscope. - Know how to use the optical microscope and recognise the different types of cells and their basic cell components.
CB1, CB5, CG7, CT3, CT8, CT10, CE1.1.1., CE1.1.2., CE1.2.2.	- Recognise and interpret the different phases of mitosis under the optical microscope.
CB1, CB5, CG7, CT3, CT8, CT10, CE1.1.1., CE1.2.2.	- Recognise and interpret the most important cell structures in electronic micrograph images.
CB1, CB5, CT3, CT8, CT10, CE1.2.2.	- Understand and experience the main basic laboratory techniques.

4. CONTENTS

a. Content studied:

- Normal structure and function of eukaryotic cells.
- Relationships between cells and their environment.
- Mechanisms of transport through membranes.
- Mechanisms of cell division, cell cycle and control mechanisms.
- Gametogenesis and fertilisation.
- Cleavage, the blastula stage and gastrulation of the human embryo.
- Ectoderm, mesoderm and endoderm formation mechanisms.
- Effects of aging. Apoptosis.
- Stem cells.
- Cellular differentiation
- Fundamental abnormalities in the normal structure and function of cells.
- Optical microscope.
- Basic laboratory techniques.

b. Topic Index

The following list details the topics studied in the content sections mentioned above (except the optical microscope and laboratory techniques topics which will be performed in practical laboratory work without necessarily being linked to a single topic in the list):

- **1.- Introduction to cellular biology**
- 1.1.- Birth and evolution of cells
- 1.2.- Cell theory
  1.3.- Characteristics of cells
- **2.- Prokaryotic vs eukaryotic cells**
  2.1.- Prokaryotic cells: characteristics
  2.1.1.- Archaea and eubacteria
    2.1.2.- Morphology and structure of bacteria
    2.1.3.- Binary fission
  2.2.- Eukaryotic cells: characteristics
  2.3- Fundamental differences between prokaryotic and eukaryotic cells
- **3.- Acellular forms**
  3.1.- Viruses
    3.1.1.- Characteristics
    3.1.2.- Structure of the viral particle
    3.1.3.- Types of virus
    3.1.4.- Viral replication cycle
    3.2.- Viroids
  3.3.- Prions
- **4.- Biological membranes**
  4.1.- Structure Fluid mosaic model
  4.2.- Functions of biological membranes
  4.3.- Main components of biological membranes
  4.4.- Lipid bilayers
    4.4.1.- Fluidity
    4.4.2.- Asymmetry
  4.5.- Membrane proteins
  4.6.- Domains
  4.7.- Glycocalyx
- **5. Membrane transport**
  5.1.- Permeability of membranes
  5.2.- Types of proteins involved in membrane transport
  5.3.-Passive transport
    5.3.1.-Simple diffusion through the membrane and by pores and channels
    5.3.2.-Osmosis and dialysis

5.3.3.-Facilitated diffusion: permease
5.4.- Active transport
5.4.1.- Primary active transport: Na+-K+-ATPase pump 5.4.2.-Secondary active transport
5.5.- Importance of gradients in mammal cells. Regulation of pH
5.6.- Macromolecule mediated transport
5.6.1.- Exocytosis
5.6.2.- Endocytosis
5.6.2.1.- Pinocytosis
5.6.2.2.- Receptor-mediated endocytosis
5.6.2.3.- Phagocytosis

- **6.- Intercellular junctions**
6.1.- interactions between cells and their environment. Cell architecture
6.2.- Types of junctions
6.2.1.- Anchoring and adherens junctions
6.2.1.1.- Cell-cell junctions
6.2.1.2.- Anchoring of cell with extracellular matrix
6.2.2.- Tight junctions
6.2.2.1.- Cell polarity and paracellular transport
6.2.3.- GAP junctions

- **7. - The Cytoskeleton**
7.1.- Functions
7.2.- Microtubules
7.2.1.- Centrosome
7.3.- Microfilaments (Actin)
7.4.- Intermediate filaments
7.4.1.- Types of intermediate filaments
7.4.2.- The nuclear lamina

- **8.-Cell movements**
8.1.-Motor proteins: General aspects
8.2.-Myosins
8.2.1.- Filopodia, lamellipodia, and pseudopodia
8.2.2.- Amoeboid movement
8.3.- Kinesins and dyneins
8.3.1.- Kinesins
8.3.2.- Dyneins
8.3.3.- Intracellular transport of membrane vesicles and organisation of organelles
8.4.-Cilia and flagella

9.- Ribosomes
9.1.- Composition and structure
9.2.- Functional areas
9.3.- Free ribosomes and membrane-bound ribosomes
9.4.- Polysomes
9.5.- Protein synthesis
9.6.- Ribosome biogenesis

- **10.- Endoplasmic reticulum**
10.1.- Intracellular compartments: Endomembrane system
10.2.- Endoplasmic reticulum: Special function (rough and smooth)
10.3.- Rough endoplasmic reticulum
10.3.1.- Functions
10.3.1.1.- Protein synthesis
10.3.1.1.1.- Protein translocation
10.3.1.1.2.- Folding and packing
10.3.1.1.3.- Protein glycosylation
10.4.- Smooth endoplasmic reticulum
10.4.1.- Functions

-ll.- The Golgi apparatus
11.1.- Intracellular vesicular trafficking
11.1.1.- Transition vesicles from the reticulum to the Golgi Apparatus
11.1.2.- Retrieval from the Golgi Apparatus to the ER
11.2.- The Golgi apparatus
11.2.1- Functions
11.2.2.- Structure
11.2.3.- Oligosaccharide synthesis

- 11.2.4.- Intercisternal transport
- 11.2.5.- Lysosomal enzymes processing

- 11.3.- Mechanisms of secretion
  - 11.3.1.- Constitutive secretion
  - 11.3.2.- Regulated secretion

- **12.- Endocytic pathways, proteasome and peroxisomes**
  - 12.1.- Lysosomes
    - 12.1.1.- Cellular digestion. Phagocytosis, endocytosis and autophagy
    - 12.1.2.- Extracellular digestion
    - 12.1.3.- Diseases of lysosomal origin
    - 12.2.- Lysosomal storage: Proteasomes
  - 12.3.- Peroxisomes
    - 12.3.1.- Structure
    - 12.3.2.- Functions and biogenesis

- **13.- Mitochondria**
  - 13.1.- Structure and function of the mitochondria
    - 13.1.1- Outer mitochondrial membrane
    - 13.1.2.- Intermembrane space
    - 13.1.3.- Inner mitochondrial membrane
      - 13.1.3.1.- Electron transport chain
      - 13.1.3.2.- ATP-synthase
    - 13.1.4.- Mitochondrial matrix
      - 13.1.4.1.- Mitochondrial metabolism
      - 13.1.4.2.- Human mitochondrial genome and mitochondrial ribosomes
    - 13.2.- Mitochondrial protein translocators and lipid import
    - 13.3.- Biogenesis of mitochondria
    - 13.4.- Mitochondria and cell ageing
    - 13.5.- Mitochondria and apoptosis
    - 13.6.- Mitochondrial diseases

-14.- Interphase nucleus
- 14.1.- Structure of the interphase nucleus
  - 14.1.1.- Nuclear envelope
    - 14.1.1.1.- Pore complex and substance trafficking
  - 14.1.2.- Nuclear lamina
  - 14.1.3.- Chromatin
    - 14.1.3.1.- Chromatin condensation levels
    - 14.1.3.2.- Euchromatin and heterochromatin
  - 14.1.4.-Nucleolus
  - 14.1.5.- Organisation of the nucleus
- 14.2.-Metaphasic chromosomes
  - 14.2.1.- Structure and ultrastructure
  - 14.2.2.- Karyotype

-15.- Cell cycle: Mitosis
- 15.1.- General aspects
  - 15.1.1.- Introduction to the study of the cell cycle
  - 15.1.2.- Phases of the cell cycle
  - 15.1.3.- Cell cycle control
- 15.2.- Cell division: Mitosis
  - 15.2.1.- Phases of mitosis
  - 15.2.2.- Types of fibres, motor proteins and organisation of the mitotic spindle
  - 15.2.3.- Cytokinesis
  - 15.2.4.- Meaning of mitosis

- **16.- Meiosis**
  - 16.1.- Sexual reproduction
  - 16.2.- Phases of meiosis
    - 16.2.1.- First meiotic division and its stages
      - 16.2.1.1.- Recombination and independent segregation of homologous chromosomes
      - 16.2.2.- Second meiotic division
  - 16.3.- Biological relevance of meiosis
  - 16.4.- Nondisjunction: effects
  - 16.5.- Gametogenesis, fertilisation and early embryo development

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- Lectures - **Theory classes in the classroom:** Consisting of explanatory teaching sessions: Contextualisation of the learning objectives and presentation by the lecturer with visual support aids which encourage debate and student participation. Practical workshops for studying images obtained via different microscopic methods (optical, electronic, fluorescence, etc.), and watching and studying complementary videos and animations which help understand the different cell processes.
- Learning based on specific laboratory teaching - **Practical laboratory work**: Practical microscope work to learn how to handle an optical microscope and identify and analyse biological samples; plus practical experiments aimed at understanding cell phenomena.
- Skills learning in the classroom and simulation environments: Practical work with computer programs - **Activities based on digital theory and practical material**: Digital material on cellular biology, including a virtual microscope platform with prepared virtual microscopic material which students can also consult in tandem outside of class time.

6. LEARNING ACTIVITIES

The types of learning activities, plus the amount of time spent on each activity, are as follows:

On campus:

Learning activity	Number of hours
Theory/practical learning activities	68 hours
Directed learning activities	17 hours
Self-study	45 hours
Tutorials	18 hours
Tests de conocimiento	2 hours
TOTAL	**150 hours**

7. ASSESSMENT

The assessment methods, plus their weighting in the final grade for the course, are as follows:

On campus:

Assessment system	Weighting
Objective theory tests	85%
Practical laboratory work and assessed activities (image recognition test)	15%

The assessment of the objective theory tests includes the evaluation of theory knowledge acquired during the explanatory classes, as well as skills and knowledge obtained in the laboratory work and practical workshops included in the subject.

The assessment of the objective image recognition tests includes the evaluation of skills and knowledge obtained in the laboratory work and practical workshops included in the subject.

The assessment of the laboratory work includes the evaluation of knowledge and skills acquired, as well the student's attitude and behaviour.

On the Virtual Campus, when you access the subject area, you will be able to see all the details of your assessment activities and the deadlines and assessment procedures for each activity. The criteria assessed in each activity will be explained in the document students have to complete for each activity.

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