Universitat Autònoma de Barcelona

2019/2020

Cell Biology and Histology

Code: 101955
ECTS Credits: 9

Degree	Type	Year	Semester
2500890 Genetics	FB	1	1

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

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External teachers

Albert Gubern

Prerequisites

Sufficient knowledge of Biology during secondary school.

Objectives and Contextualisation

This is a compulsory first-year course that introduces students to the fundamentals aspects of cell biology and tissue organization of vertebrates. In order to facilitate the learning process, the subject has been divided into two thematic modules that respectively comprise the study of the eukaryotic cell and how these cells organize themselves to form the different animal tissues.

The central object of study of cellular biology is the eukaryotic cell, the knowledge of intracellular molecules and the interactions between cells that allow the construction of multicellular organisms. On the other hand, the current object of the Histology is the study of the cellular groupings that constitute the animal tissues and their correlation with the integrating tissue function.

The student who has enrolled this course has the possibility of reaching a deeper and more integrated vision of animal organisms by taking the optional course "Developmental Biology" in the fourth year.

The specific objectives are:

1. To know the general structure, organization and functions of the different cellular organelles.

2. To acquire integrated cell concepts thanks to the ability to interrelate the different organelles from a morpho-functional perspective.

3. Master the basic terminology and be able to express concepts properly and correctly describe cellular structures.

4. To know the diversity of animal cells.

5. To know how to distinguish the cytophysiological characteristics that define the different animal tissues.

Competences

- Apply scientific method to problem solving.
- Be able to analyse and synthesise.
- Be able to communicate effectively, orally and in writing.
- Describe the diversity of living beings and interpret it evolutionally.
- Develop self-directed learning.
- Reason critically.
- Recognise and structurally and functionally describe the different levels of biological organisation, from macromolecules to ecosystems.
- Use and manage bibliographic information or computer or Internet resources in the field of study, in ones own languages and in English.

Learning Outcomes

1. Apply scientific method to problem solving.
2. Be able to analyse and synthesise.
3. Be able to communicate effectively, orally and in writing.
4. Describe the molecules, structures and processes involved in a cell's interaction and communication with the external environment and with other cells.
5. Develop self-directed learning.
6. Diagnose the cell types that, conserving their differentiation, coexist in the same tissue environment.
7. Identify animal and plant tissue in consideration of the morphology, microscopic and ultra-microscopic structure and the cytophysiology of their components.
8. Integrate the functions of the different organelles and cell structures with the overall functioning of the cell.
9. Interpret animal and plant diversity, their origin and their evolution.
10. Reason critically.
11. Relate the methodologies used in cellular biology to the results obtained.
12. Relate the structure of the different parts of a cell with their functions.
13. Use and manage bibliographic information or computer or Internet resources in the field of study, in ones own languages and in English.

Content

The content of this course consists of two well differentiated parts: Cell Biology and Histology. The study of the cell constitutes the basis for the study of tissues, which are linked to the higher level of organization, the organs. During the first weeks of the semester cell biology contents are taught to acquire basic knowledge about the structure of the cell before starting to study the different tissues present in animal organisms. In the middle of the semester and until the end, the Cell Biology lectures will overlap with the Histology ones.

MODULE I. Cell Biology

I. GLOBAL VISION OF THE CELL

Unit 1. The cell. The origin of the cell. From prokaryotes to eukaryotes. Organization of the prokaryotic and eukaryotic cell.

II. CELLULAR SURFACE

Unit 2. Structure and composition of the plasma membrane. Functions, structure and composition. Characteristics of the membrane: fluidity and asymmetry. Occluding junctions (Tight junctions).

Unit 3. Transport of molecules through the membranes. Simple diffusion. Transport of ions and small molecules: Passive transport and active transport. Communicating junctions: Gap and plasmodesmata.

III. COMPARTMENTS OF THE EUKARYOTIC CELL

Unit 4. Introduction to intracellular compartments and the cytosol. Cell compartmentation. Protein intracellular traffic. Composition and organization of the cytosol. Protein folding, post-translational modifications, protein processing and degradation.

Unit 5. Endoplasmic reticulum. Introduction to the endomembrane system: structure and composition. Functions of the smooth endoplasmic reticulum: synthesis of lipids. Functions of the rough endoplasmic reticulum: protein synthesis, protein modifications and quality control. Vesicular transport between the reticulum and the Golgi apparatus. Recovery of endoplasmic reticulum resident proteins.

Unit 6. Basic principles of vesicular transport. Type of vesicles, vesicle formation and fusion with the target membrane.

Unit 7. Golgi apparatus and secretion routes. Structure and composition of the Golgi apparatus. Glycosylation and modification of protein's oligosaccharides. Distribution of proteins in the trans-Golgi network: transport of lysosomal proteins, constitutive secretion and regulated secretion. Retention of Golgi apparatus resident proteins.

Unit 8. Routes of endocytosis. Endosomal compartment: structure, composition and classification. Endocytosis (pinocytosis and phagocytosis). Lysosomes: structure and composition. Digestion of material (autophagy and heterophagy) and genetic defects in acid hydrolases. The vacuole of plant cells.

Unit 9. Mitochondria. Structure and composition. Biogenesis: mitochondrial genome and protein synthesis; import of lipids and proteins. Functions of mitochondria: oxidations, electron transport and ATP synthesis; transport through the internal mitochondrial membrane and heat production.

Unit 10. Peroxisomes. Structure and composition. Biogenesis: import of lipids and proteins; genetic diseases related to deficient protein import. General functions of peroxisomes: oxidative reactions and oxidation of fatty acids. Specific functions in animal cells: detoxification reactions and synthesis of plasmalogens and, in plant cells: photorespiration and glyoxylate cycle.

Unit 11. Nucleus. Nuclear envelope, nuclear lamina and pore complex structure. Bidirectional transport between nucleus-cytoplasm. Nucleolus: structure and synthesis of ribosomal RNA. Chromatin: composition and structure and DNA heterogeneity. Organization of chromatin in the interphase nucleus: euchromatin and heterochromatin. Organization and structure of the chromosome.

IV. CYTOSKELETON AND CELL MOVEMENT

Unit 12. Microfilaments. Structure and composition. Actin polymerization. Actin binding proteins (ABPs). Organization of microfilaments in muscle and non-muscle cells. Cell movement. Adherens junctions: adhesion belt and focal adhesions.

Unit 13. Microtubules. Structure and composition. Polymerization of tubulin. Proteins associated with microtubules (MAPs). Labile and stable microtubules. Centrioles, cilia and flagella: structure, biogenesis and functions.

Unit 14. Intermediate filaments. Structure and composition. Polymerization. Proteins associated with the intermediate filaments (IFAPs). Associated functions. Adherent junctions: Desmosome and Hemidesmosome.

V. THE VITAL CYCLE OF THE EUKARYOTIC CELL

Unit 15. Cell cycle and Mitosis. Phases of the cell cycle. Control of the cell cycle: system components and checkpoints. Phases of mitosis and organization of the mitotic spindle. Cytokinesis.

Unit 16. Meiosis. Phases of meiosis. Synaptonemal complex and synapses of the chromosomes. Genetic recombination.

MODULE II. Histology

Unit 1. Concept of animal tissue. Cellular and extracellular components. Intercellular relationships: communication and coordination. Maintenance of tissue integrity. Classification of animal tissues.

Unit 2. Epithelial tissue. Differentiation of the surface of the epithelial cell. Cellular polarity and intercellular junctions. Basal lamina. Lining epitheliums: structural and physiological characteristics. Types of coating epithelia. Glandular epithelia: types of secretory cells. Classification and general properties of the exocrine glands. Integrative functions of the endocrine glands.

Unit 3. Connective tissue. Extracellular matrix: fibers and fundamental substance. Fixed and free cells of connective tissue. Fibroblast and fibrogenesis. Mastocytes, plasmocytes, macrophages and mononuclear phagocytic system. Varieties of connective tissue. Epithelial-conjunctive relations.

Unit 4. Adipose tissue. The adipocyte. Unilocular and multilocular adipose tissue: structure, function and distribution. Nervous and endocrine regulation.

Unit 5. Cartilaginous tissue. Cartilaginous matrix. Chondrocyte. Varieties of the cartilaginous tissue: hyaline, elastic and fibrous. Histo-physiology and involutive processes.

Unit 6. Bone tissue. Architectural organization of the bone. Bone matrix Osteoblasts-osteocytes: structure and function. Osteoclast and bone resorption. Histo-physiology. Varieties of bone tissue: laminar and non-laminar. Osteonas, interstitial and circumferential systems. Osteogenesis: intramembranous and endochondral ossification. Bone remodelling.

Unit 7. Blood. Blood plasma and formed elements. Erythrocyte: structure and function. Thrombocytes and platelets: blood coagulation. Leukocytes. Granulocytes: neutrophils, eosinophils and basophils. Agranulocytes: monocytes and lymphocytes.

Unit 8. Muscle tissue. Varieties of muscle tissue. Histo-architecture of skeletal muscle. Striated muscle fiber. Contractile device. Myofibrils and sarcomeres. Cytophysiology of muscle contraction. Cardiac muscle fiber. Intercalary discs. Smooth muscle fiber: contraction mechanism.

Unit 9. Nervous tissue. Neuron: morpho-functional regionalization. Axonic flow. Structural bases of the generation and propagation of the nervous impulse. Interneuronal synapse Neuroglia.

Methodology

The subject will be taught following the guidelines imposed by the Convergence process towards the creation of a European Higher Education Area (EHEA), endorsed by the Bologna Declaration (1999). Basically, this implies a more active participation of students in their own learning process, which translates into greater participation of students in class, more interaction among students and of these with the teacher. In addition to classroom-based (lectures) methodology, the learning process is completed through non-presential (remote) activities during the school term that translates into an important weight of the final grade of the subject. Teaching methodology and modalities are described as follows:

A) Teaching methodology in Cell Biology

Lectures

The content of the theory program will be taught mainly by the teacher in the form of master classes. The theoretical classes will be complemented by the visualization of animations and videos related to the subjects covered in class. Teacher's presentations will be available in *pdf format in the Moodle platform. It is recommended that students take this material to class to use as support when taking notes. Although it is not

essential to extend the contents of the classes taught by the teacher, unless it is specifically requested, students are advised to consult the books recommended in the Bibliography section on a regular basis to consolidate and clarify, if necessary, the contents explained in class.

In addition, the follow-up of the course also implies an active role of the students, through the preparation of some of the Units of the program. At the beginning of the course, the student will be provided with a list of the sections to be prepared and a detailed script of the aspects and contents that must be developed for each one of them. The detailed description of the contents that students must prepare will be collected in the form of a Self-Learning Work Guide, available in Moodle. The preparation of these Units by the students will help them to achieve their skills in individual or group work. It is intended that students acquire the ability to seek information from different sources and synthesize all the information collected; as well as being responsible and independent in the study of a subject.

Scientific problems Sessions

The resolution of scientific problems allows to carry out a very interesting deduction and integration exercise for the scientific training of the students. Therefore, the theoretical knowledge is complemented with the resolution of 20 problems related to the Units covered in class. The first two sessions will review basic techniques in cell biology, so that the student can later understand the experimental approaches used in the scientific problems. These contents will be taught by the teacher in the form of expository classes. The rest of sessions will be used to resolve the scientific problems proposed. Thus, these classes involve an integration of concepts and knowledge that let the student know its level of learning and are a way of approaching the student to the scientific method.

The proposed problems, the response template as well as a delivery guidelines will also be found in the Moodle platform. To solve the problems, students should form groups of four people that will meet outside of the class hours. At the beginning of the course the students will organize themselves to arrange the groups *via* the Moodle platform.

At the beginning of the programmed scientific problems sessions, each group of students will deliver the responses of a specific set of problems on a paper written by hand. The problems will then be discussed and corrected in class requiring the active participation of the students. A student will be asked at random to present the resolution of a problem and explain it to the rest of the classmates. The explanation will be evaluated by the teacher. Moreover, for each response's delivery the group of students must also prepare a portfolio where information related to the execution of problems is collected. The students will have the templates of the portfolios to answer in the Moodle platform. The information collected in the portfolio can be considered to verify and modulate, if necessary, the mark of the group work of each student. Scientific problems session's attendance is mandatory (the name of the students attending will be recorded). If a session of problems is missed in an unjustified way -medical cause- there will be a penalty in the corresponding mark of the module.

Tutorials

The tutorials will be carried out in a personalized way in the teacher's offices (door C2/024 or C2/050 at arranged hours). The students should contact to the teacher at class or by e-mail to schedule a meeting. The tutorials should be used to clarify concepts, settle the knowledge acquired and facilitate the study by students. They can also be used to solve doubts that students have about the preparation of self-learning work, or the course in general.

B) Teaching methodology in Histology

Lectures

The content of the program will be mainly taught using a classroom-based (lectures) methodology. Lectures will be complemented in the classroom by the visualization of cartoons and videos related to the topics covered in each unit. Teacher's presentations will be available in * pdf format in the Moodle.

It is strongly recommended that students bring this material to class, to use it as support when taking notes. Although it is not essential to extend the contents of the classes taught by the teacher, unless it is specifically requested, students are advised to consult the books recommended in the Bibliography section on a regular basis to consolidate and clarify, if necessary, thecontents of each lecture.

Seminars

Scheduled seminars are designed for students to work in small groups, and acquire team-building and critical thinking skills. Working groups will consist of 4 to 6 students to develop a specific topic of the program proposed by the teacher for the subsequent oral presentation and collective discussion. Thus, the follow-up of the seminars implies an active role of the students in presenting the specific topics.

The organization of the working groups and the distribution of the topics to be discussed will be carried out during the first seminar. In the remaining seminars some groups of students, chosen at random, having prepared the proposed subject, will deliver it in writing to the teacher. The same groups of students will orally present the topic to the rest of the class, with the available means in the classroom.

For the preparation of the seminars, the students should use the appropriate bibliography, as well as the scientific papers related to the topics.

Attendance at seminars is mandatory. In case of missing class for cause not justified there will be a penalty in the note of the seminars.

Tutorial

Tutorials will be done in a personalized way in the teacher's office (to be agreed with the teacher). The tutorials should be used to clarify concepts, settle the knowledge acquired and facilitate the study by students. They can also be used to solve doubts that students have about the preparation of seminars.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Cases	7	0.28	1, 5, 8, 10, 12, 11, 3, 2, 13
Lectures	55	2.2	4, 7, 8, 9, 12, 11, 2, 13
Seminars	4	0.16	4, 7, 9, 10, 3, 2, 13
Type: Supervised			
Preparation	0.5	0.02	5, 8, 12, 11, 2, 13
Type: Autonomous			
Bibliography	9	0.36	4, 5, 8, 9, 10, 12, 11, 3, 2, 13
Oral presentation	12	0.48	4, 5, 9, 10, 3, 2, 13
Problem solving	20	0.8	1, 5, 8, 10, 12, 3, 2, 13
Reading	10	0.4	5, 2, 13
Study	98	3.92	4, 5, 7, 8, 9, 10, 12, 11, 2, 13

Assessment

The evaluation of academic achievements is not simple and must take into consideration whether a level of knowledge, skills, abilities and critical maturity has been acquired in accordance with the previously established objectives. This evaluation process involves different levels of assessment: (i) student's abilities towards assimilated information, (ii) student's comprehension and its ability to relate and integrate with other knowledge, (iii) determine whether the student understands and is able to apply the methodologies and techniques acquired during the semester, and, finally, (iv) determine if students can solve experimental problems.

As explained before, the content of this subject is divided into two well-differentiated thematic modules: Cell Biology and Histology that have a weight of 67% and 33%, respectively, in the final grade of the subject. The 2 modules will only be weighted when each of the final mark in each module exceeds 5 points out of 10.

Module I Evaluation: Cell Biology

The competences of this subject will be evaluated through continuous evaluation, and will include different tests, written works, scientific problems resolution and public presentation. The evaluation system is organized in 2 sections, each of which has a specific weight in the final grade of the Cell Biology module:

Written tests-theory (75% of the global mark):

In this section, the scientific knowledge reached by each student, as well as its capacity for analysis and synthesis, and for scientific reasoning is evaluated. The individual evaluation of the theoretical concepts studied will be carried out through two written tests throughout the course (see the syllabus of the subject). The weight of the second written evaluation is a little bit higher than that of the first one (40% vs 35%, respectively) given that: 1) there is a large amount of subject and 2) implies the integration of concepts belonging to the first evaluation (see the table below).

Scientific problems (25% of the global mark):

In this section, the public presentation of problems resolution by the students of each group is evaluated in the classroom. The mark of this part comes from the arithmetic mean of the sum of the grades obtained in the oral presentations of the students from each group. This final grade will be shared by all the group members and will represent the 10% of the final grade. Likewise, the delivery of the written solutions of the problems -in the appropriate format and established term- and the corresponding portfolio will be taken into consideration (5%). Finally, the obtained grade in this block can be individually modulated downwards, depending on the portfolio and attendance. Scientific problems sessions are mandatory. In case of unjustified missed classes a penalty will be imposed: absence 1 session = reduction of 10% of the mark; absence 2 sessions = 50% reduction of the mark, absence $\geq$3 sessions = 0.

The remaining 10% of the overall mark of this section will come from the individual resolution of a scientific problem the day of the written test I (5%) and the day of the written test II (5%).

Students who do not participate in the training activities by solving scientific problems on a group work basis, can only obtain the 10% of the grade corresponding to the individual resolution of two scientific problems on the days of the written tests I and II.

Cell Biology evaluation activities	Itinerary 1	Itinerary 2
WRITEN TESTS		
Written test I	3.5	

Written test II	4.0	
Written tests retake		7.5
SCIENTIFIC PROBLEMS		
Oral presentation	1	1
Problems delivery and portfolios	0.5	0.5
Individual resolution of scientific problem I	0.5	0.5
Individual resolution of scientific problem II	0.5	0.5
TOTAL points	10	10

Report	50%	The teacher evaluates (out of 10) the works delivered by the students on the day of the seminar
Oral presentation	20%	The teacher evaluates (out of 10) the skills of each group of students in the presentation of the work
Inter-group evaluation	15%	Each group of students evaluates (out of 10) the groups that perform the oral presentation

Intra-group evaluation	15%	Within each group, each student evaluates (out of 10)each one of the classmates that make up their work group. This evaluation will be carried out in the last seminar
TOTAL	100%	

Attendance at seminars is mandatory. In case of missing class for unjustified reasons there will be a penalty in the seminar note: absence 1 session = reduction of 20% of the grade; absence 2 sessions = reduction of 40% of the grade; absence ≥3 sessions = reduction of 80% of the grade.

The histology module's recovery test will consist of a test type test of the whole theoretical programme.

In order to pass the Histology module, it will be essential to obtain a final grade, after the weighting of all the sections (written tests + seminars), equal or superior to 5 points (out of a total of 10).

Global Considerations of the Subject

Overall, the relative weight (in %) of each assessment test within each module of the subject is summarized as follows:

	Module 1 - BC	Module 2 - H
Evaluation activities		
WRITTEN TESTS (%)		
Written test I	23,45	
	26,8	

Written test II	
Writtentest III	26,4
SCIENTIFIC PROBLEMS (%)	
Oral presentation	6,7
Problems delivery & portfolios	3,35
Individual resolution of scientific problem I	3,35
Individual resolution of scientific problem II	3,35
SEMINARS (%)	
Report	3,3
Oral presentation	1,32
Inter-group evaluation	0,99
Intra-group evaluation	0,99

% Total	67	33

A student will be considered as "Non-evaluated" when the assessment activities performed have a weight lesser than 67% in the qualification of the final score of the course or module.

Students who have not passed one of the two modules (mark below 5 out of 10) will not pass the course. Despite this, in the following enrolments of the subject, repeating students will only have to evaluate the specific module they have not passed. In addition, if it has been obtained in the problem classes of the BC module (15% overall of the module mark) and/or of the H module seminars (20% overall of the module mark), a grade equal or higher than 5 points out of 10, the student will be exempt from attending these classes and the mark will be recorded for the following academic year. This exemption will be maintained for a period of two additional registrations (a total of 3 enrolments).

NB: This text has not been proofreading by a native English, so in case of any doubt or incongruity, the information provided in the Catalan/Spanish version will prevail.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Cell Biology	67%	5.5	0.22	1, 5, 8, 10, 12, 11, 3, 2, 13
Histology	33%	4	0.16	4, 5, 6, 7, 9, 10, 3, 2, 13

Bibliography

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Biología Molecular de la Célula (5ª Ed). Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P. Ediciones Omega S.A. 2016.

Molecular Cell Biology (8th edition). Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A, Martin KC. WH Freeman & Co 2016.
Biología Celular y Molecular (7ª Ed). Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A, Martin KC. Editorial Médica Panamericana 2016.

Karp's Cell and Molecular Biology (8th edition). Karp G, Iwasa J, Marshall W. Wiley 2016.
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Essential Cell Biology (5th edition) Alberts B, Hopkin K, Johnson A, Morgan D, Raff M, Roberts K, Walter P. WW Norton & Company 2019.
Introducción a la Biología Celular (3ª Ed). Alberts B, Bray D, Johnson A, Lewis J, Raff M, Roberts K, Walter P. Editorial Médica Panamericana 2011.

The Cell: a molecular approach (7th edition). Cooper GM & Hausman RE. Macmillian Learning 2015.
La Célula (7ª Ed). Cooper GM & Hausman RE. Marbán Libros S.L. 2017.

El contenido de algunos libros se puede consultar por internet en NCBI, en la siguiente dirección: http://www.ncbi.nlm.nih.gov/sites/entrez?db=Books&itool=toolbar.

MODULE II. Cell Histology

Texto atlas de Histología (ed. McGraw Hill). Gartner, L.P. Hiatt, J.L.

Histología (ed. Panamericana). Geneser, F.

Histología básica (ed. Masson). Junqueira, L.C. y Carneiro, J.

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