

Cell Biology and Histology

Code: 101955
ECTS Credits: 9

Degree	Type	Year	Semester
2500890 Genetics	FB	1	1

Contact

Name: Aurora Ruíz Herrera Moreno
Email: Aurora.RuizHerrera@uab.cat

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

Laura Tusell Padrós
Aurora Ruíz Herrera Moreno

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.

Skills

- 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 with the higher level of organization, the organs. During the first weeks of the semester only cellular 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 classes will overlap with the Histology classes.

MODULE I. Cell Biology

I. GLOBAL VISION OF THE CELL

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

II. CELLULAR SURFACE

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

Topic 3. Transport of molecules through the membrane. Simple diffusion. Transport of ions and small molecules: Passive transport and active transport. Communicating unions: Gap and plasmodesma.

III. COMPARTMENT OF THE EUCARIOTE CELL

Topic 4. Introduction to the intracellular compartments and the cytosol. Cell compartmentation. Protein intracellular traffic. Composition and structural organization of the cytosol. Folding of proteins, post-translational modification and protein processing; protein degradation.

Topic 5. Endoplasmic reticulum. Introduction to the endomembrane system. Structure and composition of the endoplasmic reticulum. 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 and recovery of resident proteins of the endoplasmic reticulum

Topic 6. Bases of vesicular transport. Type of vesicles, vesicle formation and fusion of vesicles with the target membrane.

Topic 7. Golgi apparatus and secretion routes. Structure and composition of the Golgi apparatus. Glycosylation and modifications of oligosaccharides of proteins. Distribution of proteins in the trans-Golgi network: transport of lysosomal proteins, constitutive secretion and regulated secretion; Retention of resident proteins of the Golgi apparatus.

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

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

Topic 10. Peroxisomes. Structure and composition Biogenesis: import of lipids and proteins; genetic diseases related to the import of proteins. 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.

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

IV. CYTOSKELETON AND CELL MOVEMENT

Topic 12. Microfilaments. Structure and composition Polymerization of actin. Actin binding proteins. Organization of microfilaments in muscle cells and non-muscle cells. Cell movement Adherent unions: Adhesion bands and focal contacts.

Topic 13. Microtubules. Structure and composition Polymerization of tubulin. Proteins associated with microtubules. Labile microtubules. Stable microtubules: centrioles, cilia and flagella; structure, biogenesis and functions.

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

V. THE VITAL CYCLE OF THE EUCARIOTYK CELL

Topic 15. Cell cycle and Mitosis. Phases of the cell cycle. Control of the cell cycle: system components and control points. Phases of mitosis and organization of the mitotic spindle. Cytokinesis

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

MODULE II. Histology

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

Topic 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.

Topic 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.

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

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

Topic 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 remodeling.

Topic 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.

Topic 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.

Topic 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 new 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, greater interaction between students and of these with the teacher. In addition, the subject involves the non-contact work of the student during the school term that translates into an important weight of the final grade of the subject. The following describes the organization and teaching methodology that will be followed:

A) Teaching methodology in Cellular Biology

Master Classes

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 topics covered in class. The teacher's presentations will be available in * pdf format in the Moodle of the subject. It is recommended that students print this material and take it 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 to the attendance at the classes, the follow-up of the subject also implies an active role of the students, through the preparation of some of the topics of the theoretical program. At the beginning of the course, the student will be provided with a list of the sections to be prepared as well as a detailed script of the aspects and contents that must be developed for each one of them. The material that students must prepare will be collected in the form of a Self-Learning Work Guide, available in Moodle in pdf format. The guide includes a detailed description of the contents for each topic, as well as general recommendations. The preparation of these topics by the students will help them to achieve 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. Finally, and not least, the student is expected to be responsible and independent in the study of the subject.

Problem Sessions

The resolution of scientific problems allows us 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 some 20 problems related to the topics covered in the theory classes. The first two sessions of problems will be devoted to review the main experimental techniques used in cell biology, so that the student can later understand the approaches of the problems. These contents will be taught by the teacher in the form of expository classes. The rest of sessions will be devoted to the resolution of problems corresponding mainly to practical cases related to the topics covered in the lectures. Thus, the classes of problems serve to guide the student regarding their level of learning of the subject, they involve an integration of concepts and knowledge and, finally, they are a way of approaching the student to the scientific method.

The compilation of the problems, the response template as well as the delivery guidelines for the problems will also be found in the Moodle in pdf format. The realization of the problems by the students is not face-to-face and, therefore, the students must dedicate part of their non-school time to its realization. In this sense, students should form groups of four people, who will meet together to solve the different problems proposed.

The class day of problems, each group of students will have delivered the corresponding set of problems on paper and written by hand by the different members of the group. The problems will be discussed and corrected during the face-to-face sessions, 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 with the help of the teacher.

In addition, each group of students must prepare a portfolio where information related to the realization of problems and group work is collected. The students will have the template of the portfolio to answer in the Moodle and they will have to fill it in continuously as they work on the problems. At the end of the course, and coinciding with the last problem session, each group of students must submit the portfolio completed and signed by all the members. The information collected in the portfolio can be considered to verify and modulate, if necessary, the note of the group work of each student. Class attendance of problems will be mandatory (list will be passed in class). In case of missing a class of problems in an unjustified way -cause medical- there will be a penalty in the final grade of the module.

Tutorials

The tutorials will be carried out in a personalized way in the teacher's office (door C2/050 and time to be arranged). 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.

B) Teaching methodology in Histology

Master Classes

The content of the program will be taught mainly by the teacher in the form of master classes. The theoretical classes will be complemented by the visualization of cartoons and videos related to the topics covered in class. The teacher's presentations will be available in * pdf format in the Moodle.

It is recommended that students print this material and take it 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, the contents explained in class.

Seminars

Scheduled seminars are designed for students to work in small groups, and acquire skills of group work and critical thinking. Students will be divided into groups of 4 to 6 to work on 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 will imply an active role of the students in the exposed 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

Evaluation

The evaluation of academic achievement by students is not simple and must take into consideration whether a level of knowledge, skills and abilities, and critical maturity has been acquired, in accordance with the previously established objectives when preparing the syllabus of the subject. This evaluation process involves assessing the student's abilities towards assimilated information, their comprehension and ability to relate and integrate with other knowledge, determine if the student is capable of developing with the methodologies and techniques, and finally determine if they have the ability to solve experimental problems.

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

Module I Evaluation: Cell Biology

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

Written tests (75% of the global mark):

In this section, the scientific knowledge reached by each student is evaluated, as well as their capacity for analysis and synthesis, and for scientific reasoning. 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) and a final test of recovery. The weight of the second written evaluation will be greater than that of the first given that concepts belonging to the first evaluation may be asked (see the table below).

Students who have obtained a grade lower than 4.0 (out of 10) in the written test I, will not be able to take the written test II and will have to examine the whole subject in the final test of recovery. Students who have obtained a grade lower than 4.0 (out of 10) in the written test II, should be examined for the whole subject in the final test of recovery.

Those students with a grade equal to or higher than 4.0 (out of 10) in each of the tests may ponder them. However, in order to pass the Cell Biology module it will be necessary to obtain a grade higher than 4.5 (out of 10) in the written tests (I + II test or, final recovery test).

Scientific problems (25% of the overall score):

In this section, the public presentation of the resolution of problems in the classroom by the students of each group is evaluated. The final grade of this part will be obtained by making the arithmetic mean of the sum of the grades obtained in the oral presentations. This final grade will be shared by all the members of each group and will equal 10% of the final grade. Likewise, it will be taken into consideration that each group has delivered both the written resolution of the problems in the appropriate format and established term, as well as the portfolio (5%). Finally, the grade obtained in this block can be individually modulated downwards, depending on the portfolio and attendance at the classes. Class attendance of problems is compulsory (list will be passed in class). In case of missing a class of problems in an unjustified way -cause medical- there will be a penalty in the final grade: absence 1 session = reduction of 10% of the grade; absence 2 sessions = 50% reduction of the grade, absence ≥ 3 sessions = 0

The remaining 10% of the overall mark of this section will come from the individual resolution of a scientific problem, similar to those that have been worked in class, the day of the written test I (5%) and the day of the written test II (5%) or, the day of the final recovery test, if applicable.

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

Activity of Evaluation	Itinerary 1	Itinerary 2
WRITEN TESTS		
Written test I	3.5	
Written test II	4.0	
Written test recovery		7.5
SCIENTIFIC PROBLEMS		
Oral presentation	1	1
Problems delivery and portfolio	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	10	10

The proof of recovery of the written tests will consist of a test-type test of the whole theoretical programme. Evaluation activities related to scientific problems will not be susceptible to a recovery process.

In order to pass the Cell Biology module, it will be essential to obtain a final grade, after the weighting of all the sections (written tests + scientific problems) equal to or greater than 5 points (over 10).

Module II Evaluation: Histology

Competences of this subject will be evaluated through continuous evaluation, which will include individual tests of theoretical and practical knowledge and group seminars.

The evaluation system is organized into two sections, each of which is evaluated in a independent and assigned a specific weight in the final grade of the subject:

Written tests (80% of the overall mark):

In this section, the knowledge obtained by each student is evaluated individually with test-type exams. A written test will be done at the end of the contents of the Histology program. Students who have obtained a grade lower than 4 (out of 10) in this test will not be able to weight it with the grade obtained in the seminars and, therefore, they will have to perform the final test of recovery.

Seminars (20% of the global grade):

This section assesses the capacity for analysis and synthesis of students of each group, as well as the skills of group work and oral presentation.

The seminars will be evaluated as follows:

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-grup evaluation	15%	Each group of students evaluates (out of 10) the groups that perform the oral presentation
Intra-grup 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 resumed as follows:

	Module I - BC	Module II - H
Activity of Evaluation		
WRITTEN TESTS (%)		
Written Test I	23,45	
Written Test II	26,8	
Written Test III		26,4
SCIENTIFIC PROBLEM (%)		
Oral presentation	6,7	
Problems delivery and portfolio	3,35	
Individual resolution of scientific problem I	3,35	
Individual resolution of scientific problem II	3,35	
SEMINARIOS (%)		
Report		3,3
Oral presentation		1,32
Inter-grup evaluation		0,99
Intra-grup evaluation		0,99
%	67	33

A student will be considered as evaluable when at least two of the three written tests or the final recovery test have been submitted.

To be eligible for the retake process, the student should have been previously evaluated in a set of activities equaling at least two thirds of the final score of the course or module. Thus, the student will be graded as "No Avaluable" if the weighthin of all conducted evaluation activities is less than 67% of the final score

Students can improve the grade obtained in each of the modules by submitting to the final test of recovery. The presentation to the improvement test entails the resignation by the student to the qualification previously obtained in the written tests of the module (s) in question.

Students who have not passed one of the two modules (note below 5 out of 10) will not pass the course. In spite of this, in the following enrolments of the subject, repeating students will only have to evaluate the specific module they have not passed. In addition, provided that it has been obtained in the problem classes of the Cell Biology module (15% overall of the module mark) and / or of the Histology module seminars (20% overall of the module mark), a grade > 5 points on 10, the student will be exempt from attending these classes and the note will be saved for the following academic year. This exemption will be maintained for a period of two additional registrations.

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

Actividad evaluación

PRUEBAS ESCRITAS (%)		
Prueba escrita I	23,45	
Prueba escrita II	26,8	
Prueba escrita III		26,4
PROBLEMAS CIENTÍFICOS (%)		
Exposición oral de los problemas	6,7	
Entrega problemas	3,35	
Resolución individual problema científico I	3,35	
Resolución individual problema científico II	3,35	
SEMINARIOS (%)		
Trabajo escrito		3,3
Presentación oral		1,32
Calificación inter-grupo		0,99
Calificación intra-grupo		0,99
% Asignatura	67	33

Evaluation 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 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.

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The contents of some books can be consulted online at NCBI, at the following address:

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MODULE II. Cell Histology

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