Universitat Autònoma de Barcelona

2018/2019

Cell Biology

Code: 100939
ECTS Credits: 6

Degree	Type	Year	Semester
2500253 Biotechnology	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

Prerequisites

Being a course of the first semester of the study plan of the Bachelor's Degree in Biotechnology, there are no prerequisites for taking the Cell Biology course. However, to ensure the proper following of the course and the achievement of its learning outcomes, it is recommended that students have a basic biological knowledge, specifically on the general structure of the cells and their organic components (proteins, nucleic acids, carbohydrates and lipids) as well as on the main pathways of cell metabolism.

On the other hand, in a scientific discipline like Cell Biology where many of the sources of information are in English, it is recommended that students have some basic knowledge of this language.

Objectives and Contextualisation

The Cell Biology course has a basic character within the degree and students are expected to acquire a solid knowledge about the structural organization, operation and regulation of eukaryotic cells. This knowledge is complemented with that of other basic and compulsory courses of the study plan, like Animal and Plant Biology, Genetics, Biochemistry, Animal and Plant Physiology, Microbiology or Immunology, that, as a whole, will provide Biotechnology students with a good understanding of the structural and functional organization of living organisms. Other courses of the study plan, like Instrumental Techniques or Cellular Culture, will provide a more in-depth knowledge of the techniques used for the study of cells, which in the Cell Biology course will only be introduced. On the other hand, the contents of the Cell Biology course will be complemented with practice laboratory sessions in the Integrated Laboratory 1 course.

The knowledge provided by the Cell Biology course is fundamental to correctly follow many of the aforementioned courses, as well as other optional courses of the Biotechnology study plan. For this reason, the Cell Biology course is taught in the first semester of the first year of the Biotechnology degree.

The learning objectives are that the student, at the end of the course, will be able to:

1. Recognize the main differences between prokaryotic and eukaryotic cells.

2. Describe the structure, composition and main characteristics of cell membranes.

3. Explain the organization and composition of other elements of the cell surface.

4. Describe the processes of transport across cell membranes.

5. Describe the structure, composition and function of the different compartments of the eukaryotic cells, as well as the relationships between them.

6. Explain the role of mitochondria and chloroplasts in cellular bioenergetics.

7. Describe the protein classification systems and their intracellular distribution pathways.

8.Describe the composition of chromatin and its organization in interphase and during cell division.

9. List the components of the cytoskeleton and describe their composition and structure.

10. Explain the contribution of the cytoskeleton to cell shape and movement.

11. Identify and describe the molecules, structures and processes involved in the relationship and communication of cells with the external environment and with other cells.

12. Identify the molecules involved in the regulation of the cell cycle and explain their function.

13. List and describe the different phases of mitosis and meiosis and compare the two types of cell divisions.

14. Relate the functioning of eukaryotic cells to the causes of some diseases.

15. Integrate and apply the theoretical knowledge acquired during the course to interpret the results of simple scientific experiments and to solve experimental problems.

16. Use the appropriate scientific language in the cell biology field.

Skills

- Apply the principal techniques for the use of biological systems: recombinant DNA and cloning, cell cultures, manipulation of viruses, bacteria and animal and plant cells, immunological techniques, microscopy techniques, recombinant proteins and methods of separation and characterisation of biomolecules.
- Describe the molecular, cellular and physiological bases of the organisation, functioning and integration of living organisms in the framework of their application to biotechnological processes.
- Learn new knowledge and techniques autonomously.
- Read specialised texts both in English and ones own language.
- Search for and manage information from various sources.
- Work individually and in teams

Learning outcomes

1. Describe the molecules, structures and processes involved in a cell's interaction and communication with the external environment and with other cells.
2. Explain the functioning and regulation of the cell cycle and cell division.
3. Integrate the functions of the different organelles and cell structures with the overall functioning of the cell.
4. Learn new knowledge and techniques autonomously.
5. Read specialised texts both in English and ones own language.
6. Relate the methodologies used in cell biology to the knowledge they generate.
7. Relate the structure of the different parts of a cell to their functioning.
8. Search for and manage information from various sources.
9. Work individually and in teams

Content

Unit 1. Introduction: organization of prokaryotic and eukaryotic cells. Main characteristics and differences between prokaryotic and eukaryotic cells.

Unit 2. Structure and composition of the plasma membrane. Functions, structure and composition of the plasma membrane. Characteristics of the membrane: fluidity and asymmetry.

Unit 3. Transport of molecules across the membrane. Simple diffusion and osmosis. Transport of ions and small molecules: passive transport with permeases and with channel proteins; primary and secondary active transport.

Unit 4. The extracellular matrix and the cell wall. The extracellular matrix of animal cells: composition and functions; communication between the cell and the extracellular matrix; diseases related to the extracellular matrix. The cell wall of plant cells.

Unit 5. Junctions and cell adhesion. Cell junctions: occluding, anchoring and channel-forming junctions. Cell adhesion: cell adhesion molecules.

Unit 6. Introduction to intracellular compartments and protein sorting. Cell compartmentation. Intracellular protein sorting.

Unit 7. The nucleus. Nuclear membranes, nuclear lamina and nuclear pores. Bidirectional nucleus-cytoplasm transport: protein import; protein and RNA export. Nuclear matrix. Nucleolus: structure and synthesis of ribosomal RNA. Chromatin: composition and structure; organization of chromatin during interphase; organization and structure of chromosomes.

Unit 8. The cytosol. Composition and organization. Functions: protein folding, post-translational protein modification and processing; protein degradation.

Unit 9. The endoplasmic reticulum. Introduction to the endomembrane system. Structure and composition of the endoplasmic reticulum. Functions of the smooth endoplasmic reticulum: lipid synthesis and cell detoxification. Functions of the roughendoplasmic reticulum: synthesis and translocation of soluble and membrane proteins; protein modifications; quality control.

Unit 10. The Golgi apparatus. Structure and composition of the Golgi apparatus. Basic principles of vesicular transport: types of vesicles, formation and fusion of the vesicles with the target membrane. Vesicular transport between the endoplasmic reticulum and the Golgi and inside the Golgi. Retention of endoplasmic reticulum resident proteins. Modifications of protein oligosaccharides. Metabolism of lipids and polysaccharides. Protein sorting in the trans-Golgi network: transport of lysosomal proteins, constitutive secretion and regulated secretion; retention of Golgi resident proteins.

Unit 11. Endosomes, lysosomes and vacuoles. Endosomes: structure and composition; classification; function: endocytosis. Lysosomes: structure and composition; obtention of digestion material (autophagy and heterophagy); lysosomal accumulation diseases. Vacuoles in plant cells.

Unit 12. Mitochondria. Structure and composition. Biogenesis: mitochondrial genome and protein synthesis; import of lipids and proteins. Mitochondrial function: cell respiration. Mitochondrial oxidations; electron transport; ATP synthesis; transport across the inner mitochondrial membrane; heat production.

Unit 13. Chloroplasts. Structure and composition. Biogenesis: chloroplast genome; protein import. Chloroplast functions: photosynthesis. Light reactions: light absorption, electron transport and ATP production. Dark reactions: Calvin's cycle, photorespiration.

Unit 14. Peroxisomes. Structure and composition. Biogenesis: import of lipids and proteins; de novo biogenesis. General functions of peroxisomes: oxidative reactions and oxidation of fatty acids. Specific functions of peroxisomes in animal and plant cells.

Unit 15. Microfilaments. Structure and composition. Actin polymerization. Actin binding proteins. Organization of microfilaments in muscle and non-muscle cells. Cell movement.

Unit 16. Microtubules. Structure and composition. Tubulin polymerization. Microtubule-associated proteins. Labile microtubules. Stable microtubules: centrioles, cilia and flagella; structure, biogenesis and functions.

Unit 17. Intermediate filaments. Structure and composition. Polymerization. Intermediate filament-associated proteins. Functions.

Unit 18. Cell signaling. Basic principles of cell signaling. Intracellular receptors. Cell surface receptors: G protein-associated receptors; enzyme-associated receptors. Signal integration.

Unit 19. The cell cycle. Phases of the cell cycle. Cell cycle control: components of the system and checkpoints.

Unit 20. Mitosis. Phases of mitosis and organization of the mitotic spindle. Cytokinesis.

Unit 21. Meiosis. Phases of meiosis. Synaptonemal complex and chromosome synapsis. Genetic recombination.

Methodology

The Cell Biology course consists of lectures and problem sessions. The organization and teaching methodology for these two types of educational activities are described below:

Lectures:

The content of the theory program will be taught mainly in the form of master classes, with audiovisual support. Presentations used in class will be previously available in the Moodle platform. Although it is not essential to extend the contents of the classes, unless particularly requested by the professor, it is recommended that students regularly consult the textbooks listed in the Bibliography section of this guide to consolidate and, if necessary, clarify the contents explained in class. In this sense, it is also advisable that students use the web links provided in the Moodle platform, which contain videos and animations related to the processes explained in class and self-assessment tests that students can take to periodically control their learning process.

In addition to attending classes, students will also have an active role during the course by preparing themselves some of the units of the program (units 4, 5, 14, 17 and 20), based on the guidelines provided by the professor. These guidelines are included in the Self-Learning Guide available in Moodle. This self-learning activity can be done either individually or in small working groups. The objectives are that students learn to search, interpret and summarize information gathered in the textbooks and other bibliographic sources, and learn to work independently. The questions that the students may have about the contents of these units will be discussed in special class sessions (dates provided in the Course Planning document available in Moodle).

The information collected by the students during the self-learning activities will serve as individual study material, and no deliveries will be required. It is important, however, that students plan their work according to course schedulein order to have the material prepared before the corresponding problems sessions and evaluation tests.

Problem sessions:

In these sessions, students will be divided in two groups (A and B). The dates of the sessions and the collection of problems that the students will have to solve during the course will be available in the Moodle platform.

During these sessions, students will present the resolution of experimental problems (4 problems per session), related to the contents of the theory program. It is intended that this activity serves to consolidate the contents of the course and to familiarize students with some of the techniques commonly used in cell biology, the interpretation of scientific data, and the resolution of problems based on real experimental situations. In addition, this activity aims to work on the skill of team work, through the organization of students in working groups in which all the members will have to actively participate.

The methodology will be the following:

- At the beginning of the course, the students will organize themselves in groups of four. Groups must be registered on Moodle before the deadline (see Course Planning in Moodle).

- The groups will work on the problems outside class hours. Given the experimental nature of most of the problems, students may have to search for information on the techniques used in the experimental approach before they can start working on the resolution of the problems.
- In each problem session, students will be randomly selected by the professor to present the resolution of a problem to the class. The presentations will be evaluated by the professor and the qualification obtained will be applied to all the members of the group to which the student belongs.

Student participation in the working groups and attendance to problem sessions is mandatory. To monitor the proper functioning of the working groups, each student will have to submit two group assessment questionnaires throughout the course, evaluating its ownwork and that of the other group members. These questionnaires will be available in Moodle and the deadlines for submission are indicated in the Course Planning document.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Lectures	40	1.6	1, 2, 3, 7
Problem sessions	4	0.16	1, 2, 3, 7, 9
Type: Autonomous			
Individual study	52	2.08	4, 8, 1, 2, 3, 5, 7, 9
Problems resolution (group work)	25	1	4, 8, 1, 2, 3, 5, 7, 9
Unit preparation (self-learning work)	25	1	4, 8, 1, 2, 3, 5, 7, 9

Evaluation

Evaluation consists of a continuous assessment including the following activities:

1. Multiple-choice tests (individual assessment): During the course students will have to take two multiple-choice tests. These tests will consist of a series of questions on the corresponding contents of the theory program, including those units prepared by the students (self-learning work).

The aim of these tests is to evaluate that the students have acquired the conceptual knowledge of the course and, more importantly, that they have understood and know how to integrate this information. In addition, by including questions related to the units prepared by the students, they will also allow evaluating their competence in the management of information (search, analyze and summarize information from different sources to build knowledge).

The first test will include units 1 through 11 and the second test will include units 12 to 21. Each of these tests will account for 35% of the final grade and, in order to pass the course, students must obtain a minimum score of 4 points (out of 10) in each of the two tests.

2. Oral presentations of problems resolution (group assessment): The presentations made by the students in each problem session will be evaluated by the professor and the mean grade of these evaluations will account for 15% of the final grade of the course. The evaluation will take into account not only the correct resolution of the problem but also the approach used and its comprehension by the presenting student. The grade obtained by the student will be applied to all the members of the same working group.

It is compulsory for each working group to present at least one problem in class and for each member of the group to submit the two group assessment questionnaires by the required dates. Although the results

of these questionnaires will not have a specific weight in the final grade, in case a student receives negative ratings from the rest of the group members the grade obtained by the group will not be applied to this student or it may be reduced by half.

3. Written resolution of two problems (individual assessment): Together with each of the two tests on the theory contents, the students will have to individually solve a problem, similar to those worked with the group throughout the course. The grade obtained in each problem will account for 7.5% of the final grade.

In order to pass the course, students will have to take the two multiple-choice tests and the two problem exams, be part of a working group that has presented the resolution of at least one problem in class, and submit the two group assessment questionnaires. Students must obtain a minimum grade of 4 points in each of the two tests, and a minimum overall grade of 5 points for the total evaluation activities.

Students with grades lower than 4 points in any of the two tests will have to retake the failed test/s.

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. Thus, the student will be graded as "No Evaluable" if the weighting of all conducted evaluation activities is less than 67% of the final score.

Repeating students will have the option to either keep the grade of the group work obtained in the previous year, provided it is ≥5, or retake this evaluation activity. In either case, these students will need to take the two written problems exams, in addition to the two multiple-choice tests, in order to be able to pass the course.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Fisrt multiple-choice test: Units 1 to 11 (individual assessment)	35%	1.5	0.06	4, 8, 1, 3, 5, 7, 9
Oral presentation of problems in class (group assessment)	15%	0	0	4, 8, 1, 2, 3, 7, 6, 9
Second multiple-choice test: Units 12 to 21 (individual assessment)	35%	1.5	0.06	4, 8, 1, 2, 3, 5, 7, 9
Written problem exam 1 (individual assessment)	7.5%	0.5	0.02	1, 2, 3, 7, 6, 9
Written problem exam 2 (individual assessment)	7.5%	0.5	0.02	1, 2, 3, 7, 6, 9

Bibliography

Textbooks:

Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P. **Molecular Biology of the Cell**. 6th Edition. Garland Science. New York, 2014. ISBN: 9780815344643.

Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P. **Essential Cell Biology**. 4th Edition. Garland Science. 2013. ISBN: 9780815344544

Cooper GM, Hausman RE. **The Cell: A Molecular Approach**. 7th Edition. Oxford University Press. 2015. ISBN: 9781605352909.

Hardin J, Bertoni GP, Kleinsmith LJ. **Becker's World of the Cell**. 9th Edition. Pearson. 2016. ISBN: 9780321934925.

Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A, Martin K. **Molecular Cell Biology**. 8th Edition. WH Freeman and Company. 2016. ISBN: 9781464183393.

Web links:

Available in Moodle.