Universidad Zaragoza

Academic Year/course: 2022/23

26909 - Biology

Syllabus Information

Academic Year: 2022/23
Subject: 26909 - Biology
Faculty / School: 100 - Facultad de Ciencias
Degree: 447 - Degree in Physics
ECTS: 6.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

The subject and its expected results respond to the following approaches and objectives:

The course will begin with an introduction on the origin, organization and classification of living beings, focusing on unicellular organisms.

Next there will be a section on biomolecules, dedicated to the structure and function of proteins, carbohydrates, lipids and nucleic acids.

Later we will approach the cellular structure, differentiating eukaryotic cells from prokaryotic cells, and commenting on the main cellular functions, as well as the organelles and structures involved: cellular membranes, endoplasmic reticulum, Golgi, nucleus and cytoskeleton.

We will continue with cellular metabolism, giving some general notions of bioenergetics and metabolic pathways and then moving on to a more detailed study of mitochondria, chloroplasts and peroxisomes.

We will continue with a section dedicated to the transmission of genetic information: DNA, RNA, proteins, cell cycle, etc.

The general objective of this course will be for students to acquire essential knowledge about the functioning of living organisms at the cellular level.

The concrete objectives will be:

O1. To know the origin, evolution and general classification of living beings.

O2. To know the main types of biomolecules that constitute living beings.

O3. Know the types of cells and their main characteristics.

O4. Know the cellular structure and organization.

O5. Know how the cell obtains energy and how it uses it.

O6. Know how genetic information is transmitted and how it is expressed.

O7. To know the importance of Physics in relation to biological systems and their application in research, generation and application of new knowledge based on the interdisciplinary nature of different areas of knowledge.

The aims of the course are aligned with the following Sustainable Development Goals (SDGs):

- Goal 1: No Poverty
- Goal 2: Zero Hunger
- Goal 3: Good Health and Well-being
- Goal 4: Quality Education
- Goal 5: Gender Equality
- Goal 8: Decent Work and Economic Growth
- Goal 10: Reducing Inequality
- Goal 14: Life Below Water
- Goal 15: Life On Land
- Goal 16: Peace, Justice, and Strong Institutions

1.2. Context and importance of this course in the degree

This course is part of the BASIC module of the Physics degree and, together with Geology, constitutes the optional block in this module.

1.3. Recommendations to take this course

Continuous work on the contents of the subject is recommended, consulting the recommended bibliography and resolving possible doubts with the teachers, during the development of the classes, through the use of tutorials, through the ADD or through e-mail.

2. Learning goals

2.1. Competences

On passing the subject, the student will be more competent to...

Develop work habits in a laboratory with biological material

Master the basic terminology of biology and correctly express biological concepts and principles

Understand the general, structural, and functional principles shared by living beings

To know the structure and functions of the organelles of a eukaryotic cell

Acquire an integrated overview of cell functioning and relate the activity of the different cell compartments

To become familiar with some basic instrumental techniques of biology, in particular, to interpret results obtained by optical microscopy

Understand the biological basis on which the application and extension of biology to various fields is based

To know some current lines of development of Biology in relation to Physics

Understand the relationships of living beings with the environment

Understand the basic principles that govern the evolution of living beings

2.2. Learning goals

In order to pass this subject, the student must demonstrate the following results:

1:Observe and distinguish different cell types: bacteria, animal cells, plant cells and protists

2: Recognize the structure and function of large groups of biological macromolecules

3: Distinguish the differences between different forms of cell organization

4: Know how to differentiate the different forms of water and solute transport between cell compartments

5: Isolate any cellular organelles

6: Measure the rate of photosynthesis and/or respiration in isolated chloroplasts and/or mitochondria

7: To evaluate the growth of a culture of cells subjected to drugs that alter the cell cycle

8: Handle simple structural and functional genomics computer tools

9: Assess the possible impact of virus cycles on your hosts

2.3. Importance of learning goals

The subject of Biology in the Degree in Physics is important to give the future physics graduate an overview of the functioning of living beings, mainly at the cellular level, the level at which most of the chemical reactions that define life occur. These reactions are based on complex physical parameters that are not unique to biological systems, but are particularly interesting in these systems. Due to the trend towards the multidisciplinary nature of science today, interrelating knowledge from different disciplines, the subject of Biology will contribute to broaden and make better use of the knowledge acquired during the Degree in Physics and will increase the possibilities of its application.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The evaluation of the course will be based on seminars given by the student during the course, periodic controls carried out through the teaching digital ring or in class, laboratory practices and a final theoretical assessment. The student may opt for a single final theoretical-practical assessment in the event of not being able to be adequately evaluated in the previous way, in which he/she will be able to obtain the maximum grade of the course (10). Classes are given with PowerPoint presentations, which are available to the student through the teaching digital ring, as well as any other necessary information related to the course.

Seminars

Seminars will represent up to 6% of the maximum final grade of the course (up to 0.6 points out of 10). If a student cannot impart the seminar and wants to opt for the maximum grade, he or she must take the only final theoretical-practical test.

Throughout the course, individual students will prepare and present in class short seminars on topics related to Biology, Biotechnology or Biomedicine of their choice. The content and presentation of the seminar will be scored. The duration of the presentation will be 10 minutes and then there may be a debate to discuss the topics presented between the teacher and all students present in class.

Periodic controls

Three periodic controls will be carried out to evaluate the progress of the student in the course, either through the teaching digital ring or in class, which will include the part of the agenda that has been taught so far. These controls will suppose up to 9% of the final grade of the course, with a total score of each of up to 3% of the final grade. Each of them will be evaluated on a total of 10 points, so that each one will suppose up to 0.3 points of the final grade of the course. If a student is unable to take the controls and wants to opt for the maximum grade, he or she must take the only final theoretical-practical test.

Practice classes

The realization of the practices and the elaboration of the corresponding notebook of practices, that will have to be given to the teacher at least two weeks before the date of the theoretical exam, will suppose up to 10% (up to 1 point of 10) of the final grade of the course.

There will be 5 laboratory practices, the place and date of which will be announced in advance during the course (usually in a laboratory of the Department of Biochemistry and Molecular and Cellular Biology during the months of April and May). The students will be able to select, through the Digital Teaching Ring, the group in which they want to carry out the practice.

If a student is unable to complete the internship and wants to opt for the maximum grade, he or she must take the only final theoretical-practical test.

During the course of the practices, a workbook will be drawn up describing the objective of the practice, the execution, the results obtained and the conclusions. This notebook can be completed once the practices are finished and must be given to the teacher at least two weeks before the final theoretical exam.

For the evaluation of the practices, the student's performance during the practices will be taken into account, as well as the content of the workbook. It is necessary to wear a lab coat and, if necessary, other personal protective equipment, which will be indicated sufficiently in advance. Students, at the beginning of the first practice, will receive information on safety issues in the laboratory and must sign the corresponding document indicating that they have received and understood this information.

Any student who cannot attend theoretical or practice classes, carry out controls or give a seminar, has the right to one final, theoretical-practical assessment, with which he could pass the course with the maximum grade (10). If the student chooses this option, he/she must inform the teacher at the time he/she chooses this option during the course and, in any case, at least two weeks before the final theoretical exam.

The final grade of the course is divided into the following sections:

- Theoretical exam: up to 7.5 points

  The theoretical exam will consist of two parts, one test and the other with short answer questions. It is necessary to pass both parts of the theoretical assessment in order to pass the course, that is, to obtain at least a 5 out of 10 points in each part (at least 3.75 points in each part, out of the total 7.5 points of the theoretical assessment). The multiple-choice questions consist of four possible answers, each question is scored with 1 point and each wrongly answered question discounts 0.25 points. The total is then prorated over 3.75 points. Wrongly answered short answer questions do not count negatively. Each is scored with one point and then prorated over 3.75 points. During the course, the student is given both multiple choice questions (through the digital teaching ring, with their respective correct answers) and short answer questions (these do not include the answers).

- Practices: up to 1 point.

- Seminars: up to 0.6 points.

- Controls: up to 0.9 points. Up to 0.3 points each.

If one of the two parts of the final theoretical examination (test or short answer questions) is suspended, and the final grade is equal or greater than 5, the mark appearing in the minutes will be 4,9.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process that has been designed for this course is based on the following:

The teaching-learning methodologies offered to achieve the stated objectives and acquire the competences are the following:

* Theory classes: 45 hours of theory, encouraging student participation through continuous questions and group discussions and not just presentation of information by the teacher.

* Seminars: 5 hours of seminars, in which students will make individual presentations on topics of their choice within the fields of Biology, Biotechnology and Biomedicine, with subsequent discussion in class.

* Laboratory Practices: 10 hours of practice classes. Five practices will be carried out on the central themes of the course.

* Periodic controls. Three knowledge tests will be carried out during the course, through the ADD or in class.

* Tutorials: teacher responsible for the course permanently available by email or through the Digital Teaching Ring. Face-to-face tutorials in the professor's office in the Faculty of Sciences from Monday to Thursday from 4 pm to 5 pm by appointment or at the BIFI at any time by appointment.

4.2. Learning tasks

The learning tasks are: Theory classes, seminars. laboratory practices, periodic controls and tutorials.

4.3. Syllabus

I. Introduction

Topic 1. Origin, organization and classification of living beings (2 classes)

Characteristics of living beings. Information flow in the cells. Cellular Theory. Origin of the cells. Chemical evolution and cellular evolution. Miller's experiments. Catalytic RNA. Cell membranes. Obtaining energy. Basic properties and classification of living organisms. Prokaryotes and eukaryotes. Viruses.

II. Biomolecules

Topic 2. Chemical composition of cells (1 class)

Structural levels in the cell. Bioelements. Types of biomolecules. Main functional groups in biomolecules. Stereoisomery. Biological importance of water and weak bonds. Hydrogen bridges, electrostatic interactions, Van de Waals forces, hydrophobic interactions. Acid-base balance. Osmosis.

Topic 3. Proteins (2 classes)

Amino acids. The peptide bond. Acid-base properties of amino acids. The isoelectric point. Optical properties of amino acids. Beer-Lambert's Law. The disulfide link. Protein functions. Structural levels of proteins. The folding of proteins. The structure-function relationship of proteins. Simple and conjugated, fibrous and globular proteins. Denaturation and folding of proteins.

Topic 4. Enzymes (1 class)

Discovery. Functioning. Characteristics: catalytic capacity, specificity and regulation. Classification and nomenclature. Enzymatic co-factors: metals and coenzymes. The active site. Enzymatic kinetics; Km, Vmax and Michaelis Menten equation. Regulation, pH and temperature. Reversible inhibition, competitive and non-competitive, and irreversible.

Topic 5. Carbohydrates (2 classes)

Chemical composition and functions. Monosaccharides. Stereoisomers. Aldoses and ketoses. Monosaccharide derivatives. Reducing sugars. Disaccharides and glycosidic bond. Polysaccharides: glycogen and starch. Homo and heteropolysaccharides, peptides and glycoproteins.

Topic 6. Lipids (2 classes)

Chemical composition and functions. Saturated and unsaturated fatty acids. Triacylglycerides. Sterification and saponification. Biodiesel. Membrane lipids: phospholipids, sphingolipids and glycolipids. Cholesterol and steroids. Other lipids: icosanoids, fat-soluble vitamins and electron transporters.

Topic 7. Nucleic acids (2 classes)

Nucleotides: chemical composition, structure and functions. Absorption spectra. Functions as energy exchangers. Functions as enzymatic cofactors: coenzyme A. Functions as signal transducers: the cyclic AMP. Nucleic acids. Structure and function of DNA. The double helix. Denaturalization and hybridization. Types of RNAs and their functions.

III. Basic Techniques in Biochemistry, Molecular Biology and Cellular Biology

Topic 8. Basic techniques in Molecular and Cellular Biology (2 classes)

Optical microscopy. Resolution and enhancement. Fixation, staining and assembly. Fluorescence microscopy and fluorochromes. Immunofluorescence. Transmission and scanning electron microscopy. Cell culture. Homogenization and cell fractionation. Centrifugation. Probes for the study of cells: radioisotopes, fluorescent probes. Affinity chromatography. Antibody preparation. Immunoprecipitation. Electrophoresis. Western blot.

IV. Cell Organization and Dynamics

Topic 9. The prokaryotic cell (2 classes)

Domains of living beings. Eubacteria and archaeobacteria. General characteristics of prokaryotes. Morphology and structure of prokaryotic cells. Plasma membrane and cell wall: gram-positive and gram-negative bacteria. Peptidoglycan and penicillin. Membrane transporters. Pilli and flagella. Bacterial division and sporulation. Bacterial DNA. Conjugation. Structure and gene expression. Plasmids. The lambda phage. Main bacterial lineages. Halophilic, thermophilic and methanogenic bacteria. Archaeobacteria. The bacteriorrodopsin. Replication. Archaeobacteria and eubacteria. Metabolism and ways of life of bacteria. Types of prokaryotes: autotrophs, heterotrophs; aerobes, anaerobes. The nitrogen cycle and its fixation. Annamox bacteria. Biolixiviation.

Topic 10. The eukaryotic cell (2 classes)

Differences between prokaryotes and eukaryotes. Evolution of eukaryotes. Unicellular and pluricellular eukaryotes. Protozoa, animal cell and plant cell. General characteristics of eukaryotic cells. General organization of eukaryotic cells. Cellular organs: nucleus and chromosomes, mitochondria and their origin, chloroplasts and their origin, endoplasmic reticulum, Golgi apparatus, cytosol. Membranes, endocytosis and exocytosis. Cells and organisms as experimental models: bacteria, yeasts, Arabidopsis thaliana, Drosophila melanogaster, Caenorhabditis elegans, zebrafish, mouse. The amount of DNA and the complexity.

Topic 11. Cell membranes (2 classes)

Functions of cell membranes. Selective permeability. Chemical composition. Structure of the membranes: lipid bilayer and model of the fluidic mosaic. Dynamics and asymmetry of membrane lipids. Membrane proteins and their functions. Isolation of membrane proteins. Dynamics and compartmentalization of membranes.

Topic 12. Transport through membranes (2 classes)

Simple diffusion and facilitated diffusion. Passive and active transport. The electrochemical gradient. Types of membrane transport proteins. Ionic channels and their regulation. Uniport, symport and antiport. The sodium glucose symport. The sodium-potassium pump. Osmosis. F and V-ATPases, ATP synthesis and proton pumping. Cystic fibrosis.

Topic 13. The endoplasmic reticulum (2 classes)

Cytoplasmic organelles. Import of proteins to different organelles, localization signals. The endoplasmic reticulum and its functions, smooth and rough. Import of proteins into the endoplasmic reticulum. The secretion route. The response to unfolded proteins (UPR) and chaperones. Biosynthesis of phospholipids in the ER and redistribution between monolayers, scramblases and flippases.

Topic 14. Golgi Apparatus and Vesicular Traffic (2 Classes)

Structure, organization and biogenesis. Vesicular transport. Endocytosis and exocytosis, phagocytosis and pinocytosis, transcytosis. Modification and distribution of proteins in the Golgi apparatus. Constitutive and regulated secretion. Receptor-mediated endocytosis, cholesterol and clathrine. The lysosomes. Autophagy. Membrane fusion and responsible proteins.

Topic 15. The nucleus (2 classes)

Location and functions. The interphase nucleus. Overview of gene expression in eukaryotes. The nuclear envelope and the nuclear lamina. The nuclear pore complex and the trafficking of proteins and RNA. The nuclear envelope during cell division. Types of chromatin. DNA organization in the nucleus. The nucleolus. The packaging of DNA and nucleosomes. Chromosomal segregation during mitosis. Phases of mitosis. The karyotype.

Topic 16. The cytoskeleton (2 classes)

Structure, organization and functions. Microtubules and dynamic instability. Microtubules during mitosis. Motor proteins. Cilia and flagella. Microfilaments and associated proteins. Myosin and muscle contraction. Intermediate filaments, types, intercellular junctions.

V. Cellular metabolism

Topic 17. Introduction to metabolism and cellular bioenergetics (1 class)

Universe and systems. Matter and energy. Thermodynamics. Free energy, enthalpy and entropy. Bioenergetics. Metabolic routes, anabolism and catabolism. Importance of ATP as an energy exchange molecule. Biological transporters of electrons. Role of energy transporters in cells.

Topic 18. Overview of major metabolic pathways (3 classes)

Main catabolic routes. Carbohydrate metabolism. Glycolysis as a producer of energy and molecules for other routes. Gluconeogenesis. Alcoholic and lactic fermentations. Oxidative decarboxylation of pyruvate. Lipid metabolism. Absorption of lipids from the diet. Beta oxidation of fatty acids. The biosynthesis of fatty acids. The metabolism of amino acids, transaminases. The nitrogen cycle. Nitrogen fixation in leguminous symbiotic bacteria. The citric acid cycle. The glyoxylate cycle.

Topic 19. Mitochondria, chloroplasts and peroxisomes (4 classes)

Origin, structure and function of mitochondria. Mitochondrial fission and fusion. Synthesis of mitochondrial proteins. Oxidative metabolism in mitochondria: the citric acid cycle, the electron transport chain and oxidative phosphorylation. Mitochondrial ATPase. Origin, structure and function of chloroplasts. Types of plastids. Photosynthesis, light phase and dark phase. The transport of electrons in the chloroplast. The cyclic electron flow. The chemiosmotic generation of ATP in mitochondria and chloroplasts. Biogenesis, structure and function of peroxisomes. Oxidation of long chain fatty acids and detoxification. X-linked adrenoleukodystrophy. The glyoxysomes. The photorespiration. The metabolic interaction between chloroplasts, mitochondria and peroxisomes.

VI. Transmission of genetic information

Topic 20. Introduction to molecular genetics (2 classes)

Genetic variability. Concept of gene. Organization of genetic material. Structure of the chromosomes. Basic concepts of genetics. Genotype and phenotype, locus and allele, dominant and recessive. Sexual and asexual reproduction. Mitosis and meiosis. Recombination. Mutations, duplications and translocations. Horizontal gene transfer. Mobile genetic elements, transposons and viruses. Genetic homology and evolution. Biotechnology, transgenic plants and animals, food and health applications. Cloning.

Topic 21. From DNA to proteins (3 classes)

The central dogma of molecular biology and retroviruses. Semi-conservative DNA replication. Leading and lagging strands, the Okazaki fragments. Protein DNA replication machinery: helicases, topoisomerases, DNA binding proteins, primases, DNA polymerases and DNA ligases. DNA replication in prokaryotes and eukaryotes. Mutations: types and causes. The transcription of RNA in prokaryotes and eukaryotes. Protein synthesis in prokaryotes and eukaryotes. The polysomes. The genetic code. Posttranslational modifications of proteins. Regulation of gene expression. The lactose operon. Differential gene expression in superior eukaryotic tissues. Microarrays and two-dimensional electrophoresis. The alternative splicing. Methylation and genomic imprinting.

Topic 22. The Cell Cycle and Cell Death (1 class)

Division, survival, differentiation and cell death. The cell cycle. Cell cycle check points. DNA damage detection. Mitosis and meiosis. Apoptosis and necrosis.

VII. Ecology

Topic 23.- Ecology (1 class)

Population and community biology. Structure and dynamics of Ecosystems. Interactions with the ecosystem. Intra and interspecific relations. Evolutionary Biology. Biodiversity.

Total, 45 classes (37.5 hours) (modifiable). The total can be modified in the sense that, depending on the participation of the students during the classes, some can be lengthened and others shortened. If there is remaining time at the end of the course, the classes are used for general presentations by the teacher (stem cells, aging, ...), for consulting doubts or viewing videos regarding the contents of the course, for example those available on the CD that accompanies the book Essential Cell Biology or simply for discussion in class.

Laboratory practices syllabus (5 sessions of 2 hours)

Practice 1

Introduction to the use of the optical microscope. Measurement of the size of a microscopic object.

Practice 2

Observation of cell types. Prokaryotes.

Practice 3

Observation of cell types. Pluricellular eukaryotes.

Practice 4

Observation of cell types. Unicellular eukaryotes.

Chromosome staining: observation of mitosis.

Practice 5

Isolation of chloroplasts and determination of chlorophyll.

4.4. Course planning and calendar

Theoretical classes and seminars will be given in the classroom and timetable established by the Deanery of the Faculty and published on its website. The seminars will be interspersed between the theoretical classes as the course progresses and will be announced in due course.

The dates for the global assessments are also determined by the Dean of the Faculty and published on the website.

Practice sessions, seminars and controls will be announced during the course. The workbooks must be submitted in any form at least two weeks before the theoretical examination.

The course will consist of 45 hours of theoretical classes, 5 hours of seminars and 10 hours of practice laboratory classes.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=26909