Universitat de Lleida

DEGREE CURRICULUM

MOLECULAR BIOLOGY

Coordination: FERREZUELO MUÑOZ, FRANCISCO

Academic year 2020-21

2020-21

Subject's general information

Subject name	MOLECULAR BIOLOGY
Code	101609
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION
Typology	Degree: Bachelor's Degree in Biotechnology; Course: 1; Character: COMMON; Modality: Attendance-based
Course number of credits (ECTS)	6
Type of activity, credits, and groups	Activity type: PRALAB / PRALAB / PRAULA / TEORIA Number of credits: 0.4 / 0.4 / 1.2 / 4 Number of groups: 4 / 2 / 2 / 1
Coordination	FERREZUELO MUÑOZ, FRANCISCO
Department	BASIC MEDICAL SCIENCES
Teaching load distribution between lectures and independent student work	Some 60 hours in-class teaching (some or many of these may be actually on-line classes depending on the development of the Covid-19 pandemic) and 90 hours homework.
Important information on data processing	Consult this link for more information.
Language	Mainly Spanish, although some information (videos and other materials) in English.

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
FERREZUELO MUÑOZ, FRANCISCO	francisco.ferrezuelo@udl.cat	8,8	

Subject's extra information

This course at 1st year (freshmen) provides basic knowledge regarding the function of genes; it is really a Molecular Genetics course. It requires concepts of Chemistry and Biochemistry and provides concepts that will be required in other courses of the major such as Genetics, Microbiology (microbial genetics), Genetic Engineering and Plant Biotechnology.

Learning objectives

The student must be able to:

Demonstrate knowledge about the concepts, terminology and basic mechanisms related to the structure and functioning of the genetic material.
Apply the acquired concepts to different situations and solve basic problems.

Significant competences

General competences

The degree candidate in Biotechnology must:

Be able to selectively search and use sources of information necessary to achieve training objectives.
Interpret scientific-technical information with a critical viewpoint, and be able to make presentations based on this information.
Be able to make understandable written and oral reports about the work done, with a justification based on the theoretical and practical knowledge gained (Strategic competence of the UdL).
Respect the fundamental rights of equality between men and women, the promotion of Human Rights and the values of a culture of peace and democratic values (Strategic Competence of the UdL).
Know and properly use the scientific and technical vocabulary of the different areas of Biotechnology.
Work in the laboratory applying quality criteria and good practice.
Know and know how to use the specific software and databases in the different fields of Biotechnology.

Specific competences

The degree candidate in Biotechnology must:

Know the biology of living beings in their molecular, cellular, organic and population levels, with emphasis on organisms with biotechnological interest.
Know the essential biomolecules for life and the basic concepts of enzymology.
Understand the function of genes and their regulation in response to external cell changes.

Subject contents

Unit 1. The establishment of deoxyribonucleic acid (DNA) as the genetic material of living organisms

1. State of knowledge about the chemical composition of the genetic material by 1925. 2. The transforming principle of pneumococci. 3. The transforming principle of pneumococci is DNA. 4. The chemical composition of DNA and Chargaff's rules. 5. The genetic material of bacteriophages is DNA. 6. DNA X-ray diffraction pattern and the double helix model of Watson and Crick.

Unit 2. Nucleic acids: general characteristics and techniques

1. Chemical components of nucleic acids. 2. Structural characteristics of DNA double helix. 3. RNA. 4. Basic concepts on nucleases. 5. Denaturation and renaturation of nucleic acids. 6. Techniques: "dot blots" and "macroarrays" - electrophoresis - Southern and northern "blots".

Unit 3. DNA replication

1. DNA replication models: the Meselson and Stahl experiment. 2. Chemistry of DNA synthesis. 3. Mechanism of action of DNA polymerases. 4. Processivity of DNA polymerases. 5. Fidelity of DNA polymerases. 6. The replication fork. 7. The trombone model. 8. Regulation of replication. 9. The problem of replication of linear chromosome ends. 10. The problem of chain opening and DNA supercoiling.

11. Topoisomerases: types and mechanisms.

Unit 4. Mutagenesis and DNA repair

1. Origin of mutations: Luria-Delbrück experiment. 2. Mutagenesis: general considerations. 3. DNA mistmach repair. 4. Mechanisms of DNA damage repair: direct reversal, damage excision, and repair of double-strand breaks. 5. Damage tolerance.

Unit 5. Recombination of DNA

1. Homologous recombination: genetic consequences and role in meiosis. 2. Site specific recombination. 3. Transposition: concept and type of transposons.

Unit 6. Transcription and RNA processing

1. Gene expression: the central "dogma" of Molecular Biology. 2. General characteristics of transcription. 3. Binding of RNA polymerase to DNA: transcription initiation. 4. Transcription elongation. 5. Capping and polyadenylation of eukaryotic mRNAs. 6. Transcription termination. 7. Splicing: concept, mechanism and types.

Unit 7. The genetic code and the translation of the genetic message

1. Concept and general characteristics of the genetic code . 2. Effect of mutations on the genetic message. 3. Molecular components of translation: messenger RNA, transfer RNA and wobbling, aminoacyl-tRNA synthetases, the ribosome. 4. The translation process.

Unit 8. Structural organization of cellular DNA

1. Chromatin 2. Chromatin in prokaryotes. 3. Chromatin in eukaryotes: the nucleosome. 4. Higher order structures of eukaryotic chromatin. 5. Regulation of chromatin structure: histone modification and nucleosome remodeling. 6. Nucleosome assembly during DNA replication.

Unit 9. Regulation of gene expression

1. General concepts of the regulation of gene expression. 2. Transcriptional regulation in prokaryotes. 3. Transcriptional regulation in eukaryotes. 4. Epigenetics, gene silencing and heterochromatin: X-chromosome inactivation. 5. Post-transcriptional regulation: riboswitches and interference RNAs.

Unit 10. Genomes: sequencing and editing

1. The C value paradox and gene density. 2. DNA sequencing: Sanger's method and genome sequencing. 3. General characteristics of the genomes of different groups of organisms. 4. CRISPR as a bacterial antiviral defense system and its adaptation as a genome editing tool.

Practical activities

- Problem sessions: Application of acquired knowledge in case and problem solving.

- Computer sessions: Genome databases. Polymerase chain reaction (PCR).

- Laboratory: DNA analysis by PCR and electrophoresis.

Methodology

Activity	Description	Student attendance activity		Non attendance act		Assessment	Total time
			Hours	Student work	Hours	Hours	Hours
Previous homework	The instructor provides content for each topic before the classes (face-to-face / online). Students will have at least 4 days to work on the material and fill out a questionnaire.	-	**-**	Work on the material (reading notes and viewing videos)	**36**		**36**
Lectures	Topic 1 is taught with a traditional master-class model. The rest of the subjects are taught with a flipped classroom model. In class, we will solve the doubts that have arisen from homework, we will propose some additional activities to reinforce concepts and in some cases some concepts will also be explained through the master-class model.	Students can attend class if they wish. Attendance per se is not evaluated. It is highly recommended that students participate in additional activities that may be proposed.	**36**	-	**-**	**-**	**36**

Problem sessions	Problems are worked individually or in groups at home before the corresponding session. In classroom we all solve the problems working together: preferably the students with some help from the instructor.	The student must actively participate in solving the problems in class and understand the reasoning used.	**10**	Homework on the problem assignments	**25**	**-**	**35**
Laboratory	Practical laboratory work (small group)	Execution of the lab protocol: undestanding phenomena, measuring...	**4**	-	**-**	**-**	**4**
Computer room	Practical work in the computer room (Medium size grup)	Execution of the practical work: basic knowledge of databases, understanding PCR technique, use of some bioinformatic tool...	**4**	-	**-**	**-**	**4**
Written tests	Two written tests with questions (multiple choice, short) about theoretical and practical knowledge and problem resolution.	Answering the tests	**-**	Home study	**30**	**5**	**35**
Total			**54**		**91**	**5**	**150**

Development plan

We begin with a presentation session where the functioning of the course and the ICT tools that we will use in the course are explained.

Unit 1 will be taught in two sessions with the traditional direct learning model.

The rest of the course (Units 2-9) will be addressed with a flipped classroom methodology, in which the students will have at least four days to study at home the materials provided before in-class activities.

We will have five problem sessions (two before the first exam and three in the second part of the subject).

At the end of the course we will have two computer sessions. A recorded theoretical-demonstrative session and another practical session.

Finally, we will carry out a laboratory session in small groups.

Initially, the theoretical sessions are mainly non-face-to-face (virtual by live videoconference) and the practical classes (problems, computing, laboratory) will be face-to-face. However, due to the uncertainty in the development of the COVID-19 pandemic, this programming may be altered.

Evaluation

Knowledge / Activity	Evaluative procedure		Weight in final score
Preparatory activities	Preparatory tests and other class activities		**10**
Theoretical Knowledge	First written test Units 1-5		**30**
Theoretical Knowledge	Second written test Units 6-10		**30**
Problems	First written test		**6**
Problems	Second written test		**9**
Laboratory	Second written test		**7**

Computer sessions	Online test		**8**
Total			**100**

Observations

All the scores obtained throughout the course are added together. To pass the course, it is necessary to obtain a 55% score. This percentage is equivalent to a final grade of 5.5. Whoever does not reach this threshold has the possibility of taking another test on the COMPLETE course at the end of June. This test will focus on the basic concepts of the course with more direct questions that will contain more explicit information, and therefore the level of difficulty will be lower than the tests carried out during the course. To pass this test it will be necessary to obtain 60% of the score. This percentage is equivalent to a final grade of 5 and 100% to a final grade of 7.5. This is the maximum grade obtainable on the June test.
To qualify for the 7% of the laboratory mark in the written test (second test), it is required to attend the corresponding laboratory session.

Bibliography

Most Molecular Biology or Molecular Genetics textbooks are appropriate.

A good deal of the course contents are based on:

Molecular Biology of the cell. 6th ed. Alberts et al. 2015 Garland Science.

Molecular Biology of the gene. 7th ed. Watson et al. 2014 Pearson Education Inc.

Molecular Biology of the cell: the problems book. 5th ed. wilson & Hunt. 2008 Garland Science.