

Degree programme	Type	Course
Nanoscience and Nanotechnology	OB	2

Contact lecturer

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Group languages

You can consult this information at the [end](#) of the document.

Prerequisites

There are no pre-requisites to attend this course.

Objectives

This subject integrates the description of the molecular mechanisms that occur in the processes of transmission of genetic information (replication, transcription and translation) with its technical applications.

Specific objectives:

- To know the different structures that adopt the nucleic acids, as well as the different degrees of packaging of the DNA according to the type of organism and the moment of the cell cycle.
- To know the mechanisms of replication, recombination, and DNA repair that maintain the integrity of genetic information; as well as the epigenetic modifications that are transmitted between generations.
- Understand the function of the different RNA polymerases and the mechanisms for controlling the transcription according to the type of organism.
- To know the structure and function of the ribosomes, the differences between prokaryotes and eukaryotes, and the mechanisms for controlling translation.
- Introduce the recombinant DNA tools and their applications.
- Introduce the genomic tools that allow a global approach to the study of the different processes of transmission of genetic information.

Learning outcomes

- CM22 (Identify innovations in nanobiotechnology and their economic and social impact on the field of health.) Identify innovations in nanobiotechnology and their economic and social impact on the field of health.
- CM23 (Identify the ethical and social responsibilities of developing bionanotechnology.) Identify the ethical and social responsibilities of developing bionanotechnology.
- KM38 (Identify the molecular mechanisms that are involved in genetic information transmission processes (replication, transcription and translation) and their technical application.) Identify the molecular mechanisms that are involved in genetic information transmission processes (replication, transcription and translation) and their technical application.
- KM39 (Describe the processes of cell division, as well as the principles of gene transmission, expression and regulation.) Describe the processes of cell division, as well as the principles of gene transmission, expression and regulation.
- SM32 (Use digital tools and documentary sources to obtain, analyse and present information from a critical perspective in the field of nano biotechnology, both orally and in writing.) Use digital tools and documentary sources to obtain, analyse and present information from a critical perspective in the field of nano biotechnology, both orally and in writing.
- SM33 (Use the basic methodologies used in microbiology, immunology, cell culture and molecular biology.) Use the basic methodologies used in microbiology, immunology, cell culture and molecular biology.

Contents

THEORY

1. INTRODUCTION: NUCLEIC ACIDS. STRUCTURAL LEVELS.

Chemical structure and composition. Chemical properties of DNA and modifications. Topology Structural levels of eukaryotic chromatin.

2. REPLICATION

Replication types. DNA polymerases I and III. Helicases, binding proteins, ligases and primases. Start and termination of replication in *E. coli*. Eukaryotic DNA polymerases. Telomeres and telomerases. Reverse transcriptase and retrotransposition.

3. DNA RECOMBINATION AND REPAIR

Point mutations. Mechanisms of DNA repair. Defective repair systems and cancer. DNA recombination. Homologous recombination. Site-specific recombination. Transposition. Other genetic rearrangements.

4. TRANSCRIPTION

Three-dimensional structure of prokaryotic RNA polymerase and promoter binding. Initiation, elongation and termination of transcription. Nuclear RNA polymerases and transcription control: Promoters type I and III. Promoters type II: transcription factors, response elements, enhancers and mediator. Processing of pre-mRNA: cap addition, polyadenylation, splicing and editing. Processing of other RNAs.

5. REGULATION OF EXPRESSION

Generalities. Regulation of gene expression in prokaryotes. Lac operon and trp operon. Regulation of gene expression in eukaryotes.

6. TRANSLATION

Nature of the genetic code. Aminoacyl tRNA synthetases. Structure of the ribosome. Peptide synthesis: initiation, elongation and termination. Control of translation in eukaryotes: Inhibition / potentiation of translation initiation. RNA interference and gene silencing.

7. MODIFICATION OF NUCLEIC ACIDS IN VITRO

Bacterial modification-restriction systems. Restriction enzymes. Isoschizomers. Analysis of digestions and restriction maps. Other enzymes that modify DNA.

8. CLONING TECHNIQUES

Gene manipulation: cloning and selection. Cloning vectors. Genomic libraries.

9. POLYMERASE CHAIN REACTION (PCR)

Generalities Design and optimization of the reaction. RT-PCR. Quantitative PCR.

10. HYBRIDIZATION TECHNIQUES

Generalities Hybridization techniques with and without electrophoretic separation.

11. GENETIC ENGINEERING

Production of recombinant proteins. Directed mutagenesis. Genome editing with CRISPR/CAS.

12. GENOMICS

Sequencing techniques. DNA fingerprinting. High-Throughput genomic techniques.

PROBLEMS

The content of this section consists of a certain amount of problems related to the topics developed in the magistral lectures.

LABORATORY SESSIONS

The objective of the laboratory sessions is to perform the most frequent techniques in the Molecular Biology laboratory and its application: (i) Use of the PCR technique for the analysis of polymorphisms of biomedical / forensic interest; (ii) Phenotypic and genotypic identification of a plasmid.

The laboratory sessions are organized according to the following calendar:

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Session	Analysis of human polymorphisms by PCR	Identification of a plasmid by genotype and phenotype
1	Extraction of genomic DNA Amplification of CCR5 gene by PCR	Transformation of plasmid DNA in E.coli Plate on selective media
2	Electrophoresis	Analysis of the transformed colonies Purification of plasmid DNA Digestion with restriction enzymes
3	Analysis of the results	Electrophoresis Espectrophotometric analysis of DNA Analysis of the results

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Problem solving	10	0.4	KM38, SM33
Theory and problems tests	4	0.16	KM38, SM33
Laboratory sessions	15	0.6	SM33
Problem sessions	6	0.24	KM38, SM33
Study	85	3.4	KM38, SM33
Theory lessons	30	1.2	CM22, CM23, KM38, KM39, SM32, SM33

TEACHING METHODOLOGY AND FORMATIVE ACTIVITIES

The formative activities consist of classes of theory, problems and laboratory sessions. Each of them has its own specific methodology.

Theory classes

The teacher will explain the contents of the syllabus with the support of audiovisual material that will be available to students in the Virtual Campus of the subject, in advance. These lectures will be the most important part of the theory section. It is recommended that students have the material published on the CV in printed form in order to be able to follow the classes more comfortably. Under the guidance of the teacher, the knowledge of some parts of the syllabus will have to be deepened by the students, by means of autonomous learning. In order to facilitate this task, information about locations will be provided in textbooks, web pages, etc.

Problem classes

There will be 6 sessions of problems per group, in the data announced in the calendar. For these sessions, the theory group will be divided into two subgroups of the same size, whose lists will be made public at the beginning of the course. Students will attend the sessions programmed by their group.

At the beginning of the semester a document with a list of the problems of the subject will be delivered through the Virtual Campus that will be resolved throughout the sessions. In a limited number of sessions distributed throughout the semester, problem professors will present the experimental and calculation principles necessary to work on the problems, explaining the guidelines for their resolution, and at the same time giving a part of the complementary subject to the theory classes

Students will solve the problems in and outside class hours. Non-expositive classroom sessions will be devoted to the resolution of problems. At the end of each block of contents, the students grouped in pairs will solve and deliver of a new problem proposed by the teacher. The problems can be solved and delivered in class as well as by the Moodle classroom when indicated by the professor.

Laboratory sessions

The attendance to the practices of this subject is obligatory, since they imply an acquisition of specific competences.

There will be 3 sessions of laboratory practices per group, in the data announced in the calendar. The students carry out the experimental work in pairs and under the supervision of the responsible professor. Laboratory protocols will be available in the Virtual Campus of the subject. Before beginning each practical session the student must have read the protocol and know therefore, the objectives of the practice, the background and the procedures that must be carried out. It is the student's obligation to know the specific laboratory safety and waste treatment measures.

In the practical sessions each student should have:

- A laboratory protocol.
- A notebook to collect the information of the experimental work.
- A laboratory coat.
- Safety glasses.
- Permanent marker.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

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Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Laboratory sessions	1.5	0	0	SM33
Theory partial test 2	3	0	0	CM22, KM38, KM39, SM32, SM33
Quizzes	0.5	0	0	KM38, KM39, SM33
Theory partial test 1	3	0	0	CM22, CM23, KM38, KM39, SM32
Problems	2	0	0	KM38, SM33

General considerations:

- To pass the subject, the student must obtain a global grade equal to or greater than 5 points out of 10, and the minimum grade of 4 in the theory two partial tests. If in any of these tests the qualification is less than 4, the maximum global score will be 4 points out of 10.
- 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 weighing of all conducted evaluation activities is less than 67% of the final score

Theory

The contents of the lectures will be assessed through a continuous assessment consisting of quizzes in the Moodle course and two partial tests, each covering approximately one half of the theory syllabus. Each evaluation will consist of a multiple-choice quiz. In addition, an extra exercise will be offered in each partial exam, allowing students to earn a bonus of up to 1 point toward the final course grade (0.5 points for each partial exam). This final grade bonus will only be applied once the student has passed the course with an overall grade of 5 points or higher.

(*) TO PASS THE SUBJECT IT IS MANDATORY THAT THEORY GRADE IN BOTH PARTIAL TEST WILL BE AT LEAST 40% OF THE MAXIMUM GRADE.

Those students who have not passed 40% of one or both partial tests (theory) must complete a retake exam of the corresponding partial/s. The final test will also be open to any student who, despite having passed the continuous assessment, wishes to improve the grade obtained; In this case however, the partial grade previously obtained is annulled.

Problems

Group evaluation with an additional component of individual assessment:

- 50% of the problem grade will correspond to the deliveries in pairs, of problems proposed by the professor.
- 50% of the problem grade will correspond to a maturity test (individual), where one or two problems, previously untreated in class. The maturity test will be solved and that will be performed on the date fixed for the examination of the second partial examination of theory.

The weight of the evaluation of problems will be 20% of the total of the subject. The grade obtained in the maturity test can be improved on the day of the final exam of the subject, taking into account that the

previously obtained note is canceled.

Laboratory sessions

The laboratory sessions will be evaluated with an exam after finishing the laboratory sessions. The exam includes the treated contents and the analysis of results. The weight of the laboratory evaluation will be 15% of the total of the subject.

The final grade obtained will be calculated as follows:

- a) Due partial theory tests: 6.0 points (Average of both partial, ordinary or recovery, if it exceeds 40% of the mark in each partial).
- b) Average grade of the quizzes: 0.5 points (0.25 for the quizzes of each part of the subject)
- c) Problems: 1.0 point group assessment + 1.0 point maturity exam
- d) Laboratory practices: 1.5 points laboratory exam.
- e) Optional bonus: Up to 1.0 point (0.5 in each partial test)

Single assessment.

Students who take the single assessment must do the laboratory practices (PLAB) in the face-to-face sessions scheduled in the calendar and attendance is mandatory.

The single assessment consists of a single summary test in which the contents of the entire theory program of the subject, problems, and laboratory sessions will be assessed. It will take place on the day fixed in the calendar for the second part. The theory part will be assessed with test-type questions. The problems will include the maturity test and additional exercises that replace the assignments made in class. The grade obtained in the synthesis test will account for 100% of the final grade of the subject.

The retake exam will be the same as that of students in the continuous assessment and will only incorporate the theory content and the maturity test of problems. The rest of the evaluations are not suitable for the retake. The weight of each part of the subject and the criteria for passing it are the same as for students in the continuous assessment.

Use of AI.

For this course, the use of Artificial Intelligence (AI) technologies is permitted exclusively for support tasks, such as literature searches or information gathering, text editing, or translations and other specific situations where deemed appropriate. Students must clearly identify which parts have been generated using this technology, specify the tools used, and include a critical reflection on how they influenced the process and the result of the activity. Lack of transparency in the use of AI in this gradable activity will be considered a breach of academic honesty and may result in a partial or total grade penalty for the activity, or major sanctions in severe cases.

Irregularities in the assessment activities.

Any irregularity in an assessment activity (academic fraud, plagiarism, or unauthorized use of AI, unless such use is explicitly permitted in the course syllabus) that may lead to a significant alteration of the grade will result

in a mark of 0 for that assessment. If the course syllabus establishes a minimum grade in that assessment as a mandatory requirement to pass the course, or if multiple irregularities are committed in assessment activities for the same course, the final grade for the course will be 0. In addition, disciplinary proceedings may be initiated against any student involved in such irregularities.

Bibliography

Reference textbooks:

Lewin's Genes XII. Jones & Bartlett Learning. 2017.

Fundamentals of Biochemistry: Life at the molecular level (5th edition). D. Voet & J.G. Voet Ed. John Wiley & Sons Inc. 2021

Recombinant DNA: Genes and Genomes. A Short Course. J.D. Watson, R.M. Myers, A.A. Caudy and J.A.Witkowski. 3rd ed. 2007. Ed. Freeman

Principles of Gene Manipulation and Genomics. S.B. Primrose and R.M. Twyman. 8th ed. 2016. Ed Blackwell

Molecular Biotechnology: Principles and Applications of Recombinant DNA (5th edition). B.R. Glick, J. J. Pasternak and C.L. Patten. 2017. Ed AMS

An introduction to Genetic Engineering (4th edition). Desmond S. T. Nicholl. Cambridge University Press. 2023.

Software

Not applicable.

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this [link](#). To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TE) Theory	1	Spanish	first semester	afternoon
(PAUL) Classroom practices	1	Catalan	first semester	afternoon
(PLAB) Practical laboratories	1	Spanish	first semester	morning-mixed
(PAUL) Classroom practices	2	Spanish	first semester	afternoon
(PLAB) Practical laboratories	2	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	3	Catalan	first semester	morning-mixed