

Degree programme	Type	Course
Biotechnology	OP	4

Contact lecturer

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Group languages

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

Prerequisites

There are no official prerequisites, but it is assumed that the student has previously acquired enough solid knowledge on subjects of first courses: Biochemistry, Biology, Molecular Genetics, Genetics and Basic and Advanced Instrumental Techniques.

You must qualify for the safety in laboratories test. The test can be answered in the corresponding space on the intranet and the information you need to check is in the Communication area of the Degree in Biotechnology.

Objectives

Provide a general knowledge about the molecular bases of the development of genetic diseases and deepen in the application of biochemical and molecular biology techniques for their study, diagnosis and therapeutics. In order to integrate this information, some selected examples of genetic diseases will be described at the molecular level.

Learning outcomes

- CM35 (Evaluate the different methodologies useful for obtaining disease models.) Evaluate the different methodologies useful for obtaining disease models.
- CM36 (Assess sex/gender inequalities in molecular pathology, as well as in gene therapy and in the use of vaccines and drugs.) Assess sex/gender inequalities in molecular pathology, as well as in gene therapy and in the use of vaccines and drugs.

- CM37 (Apply the basic principles that regulate the interaction of drugs with organisms.) Apply the basic principles that regulate the interaction of drugs with organisms.
- KM37 (Describe the basic concepts in the treatment of diseases.) Describe the basic concepts in the treatment of diseases.
- KM38 (Detail the molecular bases of diseases and their various mechanisms.) Detail the molecular bases of diseases and their various mechanisms.
- KM39 (Recognize the molecular elements involved in pathogenesis.) Recognize the molecular elements involved in pathogenesis.
- SM35 (Evaluate different molecular models or organisms for disease research.) Evaluate different molecular models or organisms for disease research.
- SM36 (Interpret analytical data from the main diagnostic tests and their treatment.) Interpret analytical data from the main diagnostic tests and their treatment.

Contents

THEORY

1. Introduction to genetic diseases. Definition of health and disease. Definition of genetic disease. Garrod's contribution: Inborn errors of metabolism. Data bases of genetic diseases. Monogenic, polygenic and multifactorial diseases. Mendelian inheritance. Incidence and prevalence of genetic diseases in the population.

2. Mutations in DNA as a cause of genetic diseases. Definition of mutation. Mutation rate. Types of molecular mutations and their effect on gene expression. Haemoglobinopathies. Enzymopathies: Blocking a metabolic pathway. Glucose-6-phosphatase, galactosemia and phenylketonuria deficiencies.

3. Molecular genetics diagnosis. Type and origin of analyzed samples. Prenatal and carrier diagnostics. Non-invasive techniques. Methods for detection of point mutations (SNPs), dynamic mutations, deletions and chromosomal rearrangements. Microarrays.

4. Molecular bases of inheritance and genetic diseases. Loss of function. Recessivity. Dominance. Haploinsufficiency. Negative dominant effect. Gain of function. Variable expressivity. Incomplete penetrance. Epigenetics. Genomic imprinting. Prader-Willi and Angleman syndromes. Chromosome X inactivation. Functional hemizyosity. Mosaic females. XIST gene and chromosome X inactivation center (XIC).

5. Identification of disease-associated genes. Strategies. Functional cloning. Positional cloning. Genetic and physical maps. Linkage analysis. LOD score. Zoo blots. CG isles. Exon trapping. Exon prediction. Chromosome jumping. Candidate genes.

6. Monogenic diseases: Cystic fibrosis. Alteration on chloride ion transport. Identification of the associated gene. Structure and function of the cystic fibrosis transmembrane regulator (CFTR). Effects of $\Delta F508$ and other mutations. Compound heterozygous. Therapeutic approaches.

7. Diseases caused by dynamic mutations. Classification. Proposed mechanism. General characteristics: Incomplete penetrance, anticipation, premutation. X-frangible syndrome. Effect of trinucleotide CGG expansion. Function of FMR1 gene.

8. Polygenic diseases: Alzheimer's disease. Types of lesions. Candidate and susceptibility genes. Amyloid protein precursor (APP). Role of secretases in APP processing. Presenilins. Drugs: Acetylcholinesterase inhibitors. Additional therapeutic approaches.

9. Chromosomal diseases: Down syndrome (Trisomy 21). Effect of maternal age. Phenotype. Causes. Gene dosage effect. Candidate genes. Down syndrome critical region. Animal models. Prenatal diagnosis.

10. Diseases of amino acid metabolism. Phenylketonuria and other hyperphenylalaninemias. Phenylalanine hydroxylase deficiency. Structure and effect of mutations. Neonatal diagnosis and prevention.

11. Diseases of lipid metabolism. Familial hypercholesterolemia. Cholesterol metabolism and LDL. Associated loci. Structure and function of LDL receptor. Effect of mutations.

12. Diseases of carbohydrate metabolism. Glycogen storage diseases. Galactosemias.

13. Diabetes mellitus. Type 1 diabetes. Type 2 diabetes.

14. Lysosomal storage diseases. Enzyme replacement therapy.

15. Diseases of collagen biosynthesis and structure. Osteogenesis imperfecta. Ehlers-Danlos syndrome. Alport syndrome.

16. Muscular dystrophies. Duchenne muscular dystrophy. Becker muscular dystrophy. Limb-girdle muscular dystrophy. Structure of dystrophin and dystrophin-dystroglycan complex.

17. Biochemistry and molecular biology of cancer (I). Cancer as a multicausal process. Cancer epidemiology and risk factors. Fundamental alterations in cancer cells.

18. Biochemistry and molecular biology of cancer (II). Oncogenes and protooncogenes: Activation mechanisms, membrane, cytoplasmatic and nuclear oncoproteins. Tumor suppressor genes: Molecular bases and their relationship with hereditary cancers. Cancer and apoptosis.

19. Biochemistry and molecular biology of cancer (III). Molecular bases of invasion and metastasis. Therapeutic approaches.

20. Molecular biology techniques to study disease mechanisms (I). Introduction to transgenesis techniques in

animals. DNA microinjection into fertilized oocytes.

21. Molecular biology techniques to study disease mechanisms (II). Introduction to techniques for targeted genomic alterations: Obtaining knock-out and knock-in animals using classical and CRISPR / Cas9 techniques.

22. Introduction to gene therapy. Types of vectors. Development of strategies for gene transfer into specific cells and tissues.

SEMINARS

Suggested topics:

- 1-Pigmentary retinosis
- 2-Charcot-Marie-Tooth's disease
- 3-Wolfram syndrome
- 4-Colorectal cancer
- 5-Lesch-Nyhan Syndrome
- 6-Amyotrophic lateral sclerosis
- 7-Adrenoleukodystrophy
- 8-Rett syndrome
- 9-Gaucher's disease
- 10-Malignant hyperthermia
- 11-Marfan Syndrome
- 12-Friedreich's Ataxia
- 13-Multiple Sclerosis
- 14-Colorectal cancer
- 15-Mitochondrial diseases
- 16-Immunodeficiencies
- 17-Narcolepsy
- 18-Schizophrenia
- 19-Alcoholism
- 20-Pharmacogenomics and toxicogenomics

LABORATORY PRACTICES

Genotyping, determination of cell viability and type of cell death and signaling.

- a) Extraction and purification of genomic DNA.
- b) Genotyping by PCR. Electrophoretic analysis.
- c) Determination of the lethal dose 50 of a drug on a human cell line.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Study	48	1.92	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36
Delivery of clinical cases, short questions and problem solving, through the Intranet	3	0.12	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36
Tutorials	5	0.2	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36
Laboratory practice	12	0.48	CM35, CM37, KM39, SM35, SM36
Preparation of seminars	24	0.96	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36
Seminars	10	0.4	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36
Delivery of clinical cases, short questions and problem solving, through the Intranet	12	0.48	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36
Theory lectures	30	1.2	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36

Material available on the Intranet of the subject

Teaching guide

Calendar of teaching activities (lectures, tutorials, assessments, assignments, etc.)

Visual material used by teachers in the lectures

Self-learning topics (Seminars)

Short questions, clinical cases, statements of problems

Collection test questions as an exam model

The training activities include: theory classes, seminars and laboratory practices, each of them with their specific methodology. These activities will be complemented by a series of tutorial sessions that will be additionally scheduled and a collection of deliveries for continuous evaluation.

Lectures

The content of different subjects will be explained with the support of visual material that will be available to students through the Intranet of the subject. This visual material will be written in Catalan, Spanish or English. Lecture sessions will be the most important part of the theory section.

Seminars

Knowledge of some parts chosen from the content of the different subjects will have to be searched through autonomous learning by students. It will be evaluated as oral presentations in the Seminar sessions and it will also be uploaded as a study material on the Intranet for all students to have access. Oral presentations in English will be positively valued.

The group will be divided into two subgroups (maximum 30 students per subgroup), whose lists will be made public at the beginning of the course. There will be 10 sessions of seminars during the course where students

will prepare an oral presentation for a chosen self-study (see seminar contents). Presentations in PowerPoint format and a summary of a maximum half-page will have to be sent to the teacher a week before. She/He may suggest changes or modifications during that week that must be included in the presentation.

The oral presentation of the seminar will have a maximum duration of 20 min., with the following scheme:

- Inheritance and epidemiology,
- Clinical (symptomatology),
- Molecular genetics (chromosomal location and gene identification),
- Biochemistry (mutations / allelic variants and genotype-phenotype correlation),
- Diagnosis and therapeutics.

The rest of the time will be devoted to solving doubts, answering questions, raising a debate, etc., where all those attending the seminar will be able to participate.

The oral presentation will be shared among the members of the group (2 students), so that everyone has the opportunity to speak at least for 10 min.

Attendance and accomplishing oral presentations at the Seminars are mandatory for all students, except in cases where there is a documented justification. Active participation of the students in the seminars will be rated, so that it will have an impact on the seminar grade. Lack of attendance will discount a percentage of the seminar mark.

Delivery of clinical cases, short questions or problems

Every 10-12 theory topics a collection of questions that may contain clinical cases, short questions or problems will be delivered through the intranet tool and that will have to be answered back within a short period of time, that will be determined when the questions are proposed. Questions will be related to concepts explained in the lectures but also to self-learning topics that must be searched and studied through autonomous learning by the students.

Tutorials

Tutorials will be carried out as requested by students. If the number of requirements is extremely high, especially for midterm exams or the resolution of clinical cases or short questions, up to 2 classroom tutorials would be scheduled and they will be announced on a timely basis through the intranet. The objective of these sessions will be to resolve doubts, review basic concepts, solve problems or clinical cases proposed through intranet short questions, guide on the consulted sources of information and carry out debates on the topics for which there are planned autonomous learning or that have been proposed by the teachers. These sessions will not be lectures nor will be treated new topics from the official content of subjects, but will be sessions of debate and discussion.

Laboratory practices

Three sessions of 4 hours each will be programmed. The hours and laboratories could be checked sufficiently in advance on the intranet of the course and on the website of the BioScience School.

The subject will be taught in small groups of students, in the practice laboratory.

Students will have a Practices Manual before the start of the practical sessions and, where appropriate, a questionnaire that will be available on the intranet.

In each practical session, it is mandatory that the student wears: his own gown, lab glasses and the Practices Manual. You also have to bring a notebook, where each student will write down the observations made as well as a permanent marker.

To carry out the laboratory practices, students will work in pairs under the supervision of the professor in

charge. At the beginning of each session, the teacher will make a brief theoretical explanation of the content of the practice and the experiences to be carried out by the students.

In order to achieve good performance and acquire the competences corresponding to this subject, it is essential that the student will comprehensively read the Practices Manual, familiarize with the practices that will be carried out in each session, as well as the methodology that will need to be applied in each case.

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.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Delivery of clinical cases, short questions and problem solving, through the Intranet	10%	1	0.04	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36
Attendance, attitude, aptitude and laboratory work dossier	15%	0	0	CM35, CM37, KM39, SM35, SM36
Theory midterm individual exams	60%	4	0.16	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36
Oral presentation and participation in seminars	15%	1	0.04	CM35, CM36, CM37, KM37, KM38, KM39, SM35, SM36

The evaluation of this course will have the format of continuous assessment with a recovery final test. The objective of the continuous assessment is to encourage the student's effort throughout the semester, allowing them to monitor their degree of follow-up and understanding of the subject. The final test of recovery is used to verify that the student has reached the necessary degree of integration of knowledge of the course.

Theory (6/10)

Individual assessment through:

- Two midterm tests with short questions.
- A final proof of re-assessment that will have the same format as the midterm exams and will cover the entire subject of the course. This exam is intended for students who have not previously passed midterm tests. 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 weight in of all conducted evaluation activities is less than 67% of the final score.

The date, time, and place of the tests can be consulted sufficiently in advance on the Moodle class of the course or on the website of the BioSciences School.

Delivery of answers for clinical cases, problems, and continuous assessment tests through the intranet (1/10)

There will be a maximum 2 deliveries

Seminars (1.5/10)

Assessment of teamwork:

The obtained mark will be the same for all the members of the team, as long as all of them have prepared and

exhibited in an equivalent manner. The involvement of the different members of the team will be verified through a small individual and confidential survey. Seminars presentation in English will receive an extra point in the final seminar's mark. The participation (questions, interventions, debate, etc.) of the students attending the seminars will be positively valued. The presentation of the seminars in English will receive 1.5 extra points in the seminar mark. There will be a question about the content of the seminars in the 2nd midterm test as well as in the final proof of re-assessment.

Evaluation of individual learning:

The two sections (Theory and Seminars) are inseparable so the student must participate, and be evaluated, in both to overcome the matter. Therefore, participation in the seminars is mandatory, both on the day of the oral presentation and the attendance at the other seminars of the peers. Students missing more than 40% of programmed sessions will be graded as "No Avaluable". The active participation of the students in the seminars will have an impact on the seminar grade. A selection of seminars, which are also part of the contents of the subject, will be evaluated with a question to the examination of the 2nd midterm exam and will contribute in a proportional way to the mark of this exam. The recovery exam will also include a seminar question.

Laboratory practices (1.5/10)

Attendance to laboratory practice sessions is mandatory. Any delay or lack of assistance must be documentarily justified. In order to be able to pass the course, at least 80% of the scheduled sessions are required.

Students must write a report where they will present and discuss the results obtained during the practical sessions. This work will represent 75% of the practice mark. The date of delivery of the dossier will be fixed by the teacher. In addition, the practical ability of each group of students will be evaluated taking into account the results obtained, which will represent 25% of the practical note.

The assessment will be based not only on the elaboration of the practices dossier but also on the attitude and aptitude of the student during the sessions.

Students who do not have a practical grade score of 5 or more can not pass the course.

In the case of not passing the course and from the second enrollment, the repeating students with a practice mark equal to or greater than 5, will not have to attend the sessions of practices nor they have to evaluate of practices. This exemption will be maintained for a period of two additional tuition fees.

Requirements to pass the course

It is necessary to obtain a final grade equal to or greater than 5 to pass the course, either through midterm or through the final re-assessment test. In order to be able to do the average between midterm tests, without going to the final re-assessment test, the student will have to obtain in the two midterm exams a qualification equal to or higher than 4.5. The topics corresponding to the partial theory tests with a qualification of less than 4.5 will be evaluated in the final re-assessment test, where it will be also necessary to obtain a qualification equal to or higher than 4.5 for each midterm topic to be able to average with the scores of the rest of the activities. However, those students who have passed the partial tests of theory and want to improve their qualifications may choose to attend the final test of re-assessment for the totality of the subject or only one of the midterm exams. The student who is attending a re-assessment exam is resigning the partial/s scores.

The students from a second enrolment of the course will not have to carry out the educational activities or the evaluations of those activities passed with a score higher than 5, like the seminars and the delivery of questions of continuous assessment.

The student will obtain the "No avaluable" qualification if any of the two assumptions are given: 1) The number of assessment activities carried out has been less than 67% of those programmed for the course. 2) The evaluation of all the assessment activities carried out does not allow achieving the global rating of 5 in the event that it had obtained the maximum grade in all of them.

UNIQUE EVALUATION

Students taking the single assessment must present their seminar (SEM) on the day that corresponds to them, according to the seminar calendar that will be announced through the subject's Virtual Campus. The presentation of seminars in English will receive an extra and a half points in the seminar mark. The assessment and weight on the final grade of the seminars will be the same as those of the continuous evaluation (SEM 15%).

Attendance to laboratory practices (PLAB) will also be mandatory in face-to-face sessions, it is a requirement to approve them, and they will have a weight of 15%. To pass the subject, an attendance of at least 80% of the scheduled sessions is required.

The single assessment consists of a single summary test (with short questions) on the contents of the entire theory program. Both, in the synthesis test and in the re-assessment exam, there will also be a seminar question.

The mark obtained in the synthesis test and the re-assessment test is 60% of the final grade of the subject, the mark obtained in the assignments through the Virtual Campus is 10%, the laboratory practices grade is 15%, and the seminars the remaining 15%.

The single assessment test will coincide with the same fixed date in the calendar for the last continuous assessment test and the same re-assessment system will be applied for the continuous assessment.

To pass the subject it is necessary to obtain a minimum final mark of 5 out of 10 in the overall mark of the subject and to be able to average the marks of the different activities a minimum of 4.5 must be obtained in the synthesis and the re-assessment tests.

USE OF AI TOOLS

In this course, the use of Artificial Intelligence (AI) technologies is permitted as an integral part of developing the assignment, provided that the final result reflects a significant contribution from the student in analysis and personal reflection. The student must clearly identify which parts were generated using this technology, specify the tools used, and include a critical reflection on how they influenced the process and the final result of the activity. Failure to be transparent about the use of AI will be considered academic dishonesty and may result in a penalty on the activity grade, or more serious sanctions in cases of misconduct.

ACADEMIC MISCONDUCT

Any irregularity committed during an assessment activity (academic misconduct, plagiarism, or improper use of AI, unless such use is expressly authorized in the course syllabus) that may lead to a significant alteration of the grade will result in that activity being graded as 0. If the course syllabus stipulates that obtaining a minimum mark in this assessment is an essential requirement to pass the course, or if multiple irregularities occur in the assessment activities of the same course, the final grade for the course will be 0. Furthermore, disciplinary proceedings may be initiated against any student who incurs any of these irregularities.

Bibliography

Basic Bibliography

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Complementary Bibliography

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Nussbaum, R.L., McInnes, R.R., Willard, H.F. *Thompson & Thompson Genetics in Medicine with clinical case studies*. 6th ed. W.B. Saunders. Philadelphia, 2004.

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Internet addresses

On-line Mendelian Inheritance in Man (OMIM). <http://www.ncbi.nlm.nih.gov/Omim/>

Molecular Medicine MedPulse®. <http://www.medscape.com/px/splash>

Medline Plus®. <http://www.nlm.nih.gov/medlineplus/>

Genes and Disease.

<http://www.ncbi.nlm.nih.gov/books/bv.fcgi?call=bv.View..ShowTOC&rid=gnd.TOC&depth=2>

Software

None.

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	44	Catalan	second semester	morning-mixed
(PLAB) Practical laboratories	441	Catalan	second semester	afternoon
(SEM) Seminars	441	Catalan	second semester	morning-mixed
(PLAB) Practical laboratories	442	Catalan	second semester	afternoon