Universitat Autònoma de Barcelona

2022/2023

Instrumental Techniques

Code: 101966
ECTS Credits: 6

Degree	Type	Year	Semester
2500890 Genetics	FB	2	2

Contact

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Use of Languages

Principal working language: spanish (spa)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Teachers

Jordi Vilardell Vila

Prerequisites

There are no official prerequisites, but it is assumed that the student has previously acquired enough solid knowledge on the following subjects to follow this subject correctly:

- Basic concepts of Biochemistry, specially the physico-chemical characteristics of macromolecules
- Basic concepts of "Genètica molecular d'eucariotes"
- Basic computer user skills (Internet, office IT)
- Good comprehension of English written publications and textbooks

Objectives and Contextualisation

In this subject, instrumental foundations that are required to carry out genetic research will be taught. There are two distinct topics that will be treated as two independent modules: the computer tools to manage genetic data (Module of programming principles) and the methods and experimental techniques for the manipulation of biomolecules (Module Techniques in biochemistry).

MODULE I: PROGRAMMING PRINCIPLES

Nowadays, research in genetics and genomics is carried out with huge amounts of data from DNA sequences. In order to process this information, researchers must know and use computer tools. How is this information stored? How can we extract information in a flexible way? How can we obtain new information from it? Knowing the programming principles is fundamental to allow researchers to create programs to manage and analyze the genetic data.

The goal of this module is to explain the theoretical and practical principles of computer science, placing special emphasis on programming. Python will be learnt, the most popular programming language among bioinformaticians. It is versatile, ease to learn and it was designed to manage sequences. R will be introduced, too. Theoretical classes will be complemented with the corresponding module from "Laboratori Integrat IV".

MODULE II: INSTRUMENTAL TECHNIQUES IN BIOCHEMISTRY

The general objective is the students learn the instrumental techniques that are developed in a laboratory and that they may need throughout their studies and professional activity.

This objective can be specified in:

-Acquire and understand the theoretical basis of the main instrumental techniques
-Apply these techniques in the field of genetics
-Strengthen the self-learning ability of the student. The student must learn to obtain information and acquire the habit of using this information critically.
-Increase student interestinthe technical aspect of science.

Competences

- Be able to analyse and synthesise.
- Describe and identify the structural and functional characteristics of nucleic acids and proteins including their different organisational levels.
- Design experiments and interpret the results.
- Develop self-directed learning.
- Know and understand the underlying chemical basics of the molecular properties of genetic and biological processes in general.
- Know, apply and interpret the basic procedures of mathematical calculation, statistical analysis and IT, the use of which is indispensable in genetics and genomics.
- Reason critically.
- Recognise and structurally and functionally describe the different levels of biological organisation, from macromolecules to ecosystems.
- Understand and describe the structure, morphology and dynamics of the eukaryotic chromosome during the cell cycle and meiosis.
- Use and manage bibliographic information or computer or Internet resources in the field of study, in one's own languages and in English.

Learning Outcomes

1. Be able to analyse and synthesise.
2. Describe electronic microscopy techniques applied to nucleic acids.
3. Describe the basic techniques for the analysis, purification and characterisation of biomolecules.
4. Design experiments and interpret the results.
5. Develop self-directed learning.
6. Explain the basics of databases and computer programming and develop applications.
7. Reason critically.
8. Recognise the basic theory and apply the suitable techniques for the structural and functional characterisation of proteins and nucleic acids.
9. Resolve problems with techniques and methods.
10. Resolve problems with the physical and chemical functions and properties of biomolecules.
11. Use and manage bibliographic information or computer or Internet resources in the field of study, in one's own languages and in English.

Content

Module I: PROGRAMMING PRINCIPLES

Unit 1. Introduction to the use of computer tools to the study of genetics.

Unit 2. Programming. Basic concepts of programmation. The importance of knowing how to program. Programming languages.

Unit 3. Programming with Python I. Why Python?: characteristics, installation and programming tools. Programming strategis. How a program works.

Unit 4. Programming with Python II. Variables and data structures. Basic operations. Input and Output. Reading and writing files.

Unit 5. Programming with Python III. Flow control: conditional instructions, operators and loops.

Unit 6. Programming with Python IV. Regular expressions: pattern matching.

Unit 7. Programming with Python V. Creating functions. Scripts and arguments. Introduction to BioPython.

Unit 8. Programming with R.

Module II: INSTRUMENTAL TECHNIQUES IN BIOCHEMISTRY

Unit 1: Basic Principles of absorption spectroscopy. Lambert-Beer Law. Spectrophotometers. Spectroscopic analysis of biopolymers. Fundamentals of spectrofluorimetry. Spectrofluorimeter. Applications.

Unit 2: Centrifugation. Fundamentals.Sedimentation Coefficient. Factors on which the sedimentation coefficient depends. Instrumentation: preparative and analytical ultracentrifuge. Centrifugación techniques.

Unit 3. Chromatographic techniques. Introduction. Fundamentals and characteristics. Chromatography type: gel filtration, ion exchange, hydrophobic, affinity. High Performance Liquid Chromatography (HPLC).

Unit 4: Purification Strategiesof macromolecules. Stages of purification. Optimization of each stage. Preparative techniques of nucleic acids: plasmid DNA, bacteriophage DNA, genomic DNA, total RNA and messenger RNA.

Unit 5: Electrophoretic techniques. Protein Electrophoresis: SDS-PAGE, Two-dimensional gel electrophoresis, native electrophoresis. Nucleic acidelectrophoresis: native, denaturing, pulsating field, thermal gradient, electroelution.

Unit 6. Hybridization techniques: Western-blot, Southern-blot, Northern-blot, Southwesthern, Microarrays, FISH, in situ hybridization. Labeling techniques

Unit 7: Polymerase Chain Reaction: PCR. Fundamentals of the technique. Primers design . Set up of the reaction. Applications. RT PCR and Real time PCR.

Unit 8: Recombinant DNA Technology.

Unit 9: Immunological techniques. Preparation of monoclonal and polyclonal antibodies. Antigen-antibody reaction.

Methodology

Teaching methodology includes theory classes, problem classes, seminar classes,

Module 1: 14 h (theory classes), 7h (Seminar and problem classes)

Module 2: 20h (theory classes), 4h (Seminar and problem classes)

Also included 6h for tutoring in group or individual

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Seminars and problem classes	11	0.44	5, 4, 6, 7, 9, 1, 11
Theory classes	34	1.36	2, 3, 5, 4, 6, 7, 8, 9, 10, 1, 11
Type: Supervised			
Group and individual tutoring	6	0.24	2, 3, 5, 4, 6, 7, 8, 9, 10, 1, 11
Prepartion of materials	1	0.04	5, 4, 7, 1, 11
Type: Autonomous			
Bibliographic research	5	0.2	5, 7, 11
Problem resolution	34	1.36	5, 4, 6, 7, 1, 11
Study	40	1.6	7, 1, 11
Text readings	7	0.28	5, 7, 11
Work redaction	6	0.24	5, 4, 7, 1, 11

Assessment

The compentences will be evaluation through continuous assessment including 2 midterm exams, a reassessment test, an optional activity to get a higher mark, resolution of problems and participation within the class.

Module I: PROGRAMMING PRINCIPLES

1. Theory (70% of module)

A written test at the end of this module. It will consist of theoretical questions, relation of concepts, applied questions and resolution of problems.

2. Seminars (30% of module)

Active participation in the resolution of exercises and the delivery of problems account for 30% of the final grade of this module. In the case of repeaters, the seminar note for previous courses is not saved.

Theory and seminars notes cannot be to be promised if the mark of the written theory test is not equal or superior to 5, therefore the students who do not pass it (note <5) will have to appear to the examination of recovery .

Theory requires a minimum grade of 5 points (out of 10) in order to add the seminar grade for the final module grade. Final module grade requires a minimum grade of 5 points (out of 10) in order to pass the module. If any grade is below 5, the student should do the reassessment test.

Module II: INSTRUMENTAL TECHNIQUES IN BIOCHEMISTRY

1. Theory (85% of module)

A written test at the end of this module. It will consist of short questions relating concepts, definitions and a block multi-choice questions.

2. Seminars (15% of module)

An individual written test will be done with the content of theseminar sessions. The final grade of these seminars will be obtained from the mark obtained in this individual test and from the participation of each of the groups in the seminar sessions or by the tasks oriented by the professor.

Theory requires a minimum grade of 5 points (out of 10) in order to add theseminar grade for the final module grade. Final module grade requires a minimum grade of 5 points (out of 10) in order to pass the module. If any grade is below 5, the student should do the reassessment test.

For both modules

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. So, the student will be graded as "Not evaluable" if the weighting of all conducted evaluation activities is less than 67% of the final score.

Reassessment test: The same day will be held for both modules for those students who have not passed each of the midterm tests with a mark equal or greater than 5 (out of 10) or having a final module grade equal or greater than 5 (out of 10). The reassessment of each of the module is independent.

The reassessment test only allows to recover the percentage of the midterm test that has been failed. The grades corresponding to the activities of seminars and work assignments, due to their characteristics, can not be reassessed.

The grade from the reassessment test can be added to the seminar grade if it is equal to or greater than 4.

In order to get a higher mark, those students who have passed the midterm exams 1 and 2may opt for a final test. The student who takes this exam renounces the previous note. It is not possible to get a higher grade through a written work or other types of activities. Exam difficulty level will correspond to the objectives of thesubject and, therefore, may be higher than themidterm exams. The new grade obtained cannot be used to obtain "honors".

General considerations on theevaluation:

Students who have not followed the continuous assessment will be evaluated in the reassessment test scheduled at the end of the semester. However, the maximum qualification that is possible to achieve in this situation is equivalent to approximately 80-90% of the total of the note, the same thatcorresponds to the midterm exams.

Instead, to pass the subject it is not necessary to be evaluated of the seminar part.

To pass the course, it is necessary to obtain a final grade equal to or greater than 5 for each of the modules. The final grade is the arithmetic mean of both modules, provided that the note for each module is greater than or equal to 5.

The revision of written tests will be carried out on a concerted day and place.

Students who can not attend an individual assessment test due to a justified reason and provide corresponding official documentation to the Degree Coordinator, will be entitled to take the test on another date.

Repeaters (students of second enrollment), who have one of the modules passed (approved with a grade equal to or greater than 5), it is only necessary to evaluate the module that they have NOT passed.

Any aspect that is not contemplated in this guide will follow the regulations of evaluation of the Faculty of Biosciences.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Midterm exam module 1	35	2	0.08	5, 4, 6, 7, 9, 1, 11
Midterm exam module 2	42.5%	2	0.08	2, 3, 5, 4, 7, 8, 9, 10, 1, 11
Seminars and work deliveries at the CV module 1	15%	0	0	5, 4, 6, 7, 1, 11
Seminars and work deliveries at the CV module 2	7.5%	2	0.08	3, 5, 4, 7, 1, 11

Bibliography

Module I: PROGRAMMING PRINCIPLES

• Mitchell L Model. Bioinformatics Programming Using Python. O'Reilly. 2009.

Module II: INSTRUMENTAL TECHNIQUES IN BIOCHEMISTRY

• Creighton, T.E., The biophysical chemistry of nucleic acids & proteins, Helvetian Press, 2010

• Metzemberg, S., Working with DNA, Ed, Taylord & Francis Group. California, 2007

• Sheehan, D.,Physical biochemistry : principles and applications 2nd ed. Chichester: John Wilwy & Sons, 2009

• García-Segura, JL Técnicas Instrumentales de Análisis en Bioquímica. Editorial Síntesis. Madrid. 1999

• White BA PCR Protocols. Current Methods and Applications. Humana Press. 1993

Software

Module I: PROGRAMMING PRINCIPLES

- Anaconda and Python
  https://www.anaconda.com/products/distribution
  It will be used during the classes and for homework deliveries
- R studio https://www.rstudio.com/products/rstudio/
- R https://cran.r-project.org/