UAB
Universitat Autònoma de Barcelona

Bioinformatics

Code: 100780
ECTS Credits: 6

2025/2026

Degree	Type	Year
Biology	OB	3

Contact

Name: Daniel Yero Corona

Email: daniel.yero@uab.cat

Teachers

Josep Antoni Perez Pons

Juan Camilo Ortiz Ortiz

Jose Francisco Sanchez Herrero

Teaching groups languages

You can view this information at the end of this
document.

Prerequisites

In order to take this subject, it is recommendable that the students have previously acquired enough solid
knowledge on subjects like Genetics, Molecular Genetics, Microbiology, Structure and Functions of
Biomolecules and Further Cell Biology. We recommend a basic understanding of English, although it is not
mandatory.

Objectives and Contextualisation

The treatment and computer analysis of molecular data has acquired a fundamental role in the modern Biology
and the topics that will be taught in this subject are a basic introductory vision of bioinformatics. The main
objectives are:

- To provide the basic bioinformatics knowledge that allows the use of search tools to interrogate the
  main public databases in Life Sciences and the different approaches for the computational analysis of
  nucleic acid and protein sequences.
- To give a perspective of the potential of this discipline in the field of research as well as in the
  professional field.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Apply statistical and computer resources to the interpretation of data.
- Be able to analyse and synthesise
- Be able to organise and plan.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Obtain information, design experiments and interpret biological results.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.

Learning Outcomes

1. Analyse a situation and identify its points for improvement.
2. Apply statistical and computer resources to the interpretation of data.
3. Be able to analyse and synthesise.
4. Be able to organise and plan.
5. Critically analyse the principles, values and procedures that govern the exercise of the profession.
6. Propose new methods or well-founded alternative solutions.
7. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
8. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
9. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
10. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
11. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
12. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
13. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
14. Use and interpret data sources and understand the fundamental principles of bioinformatic analysis in order to establish the corresponding relations between structure, function and evolution.

Content

Topic 1. Databases in Health and Life Sciences. Introduction to bioinformatics and molecular databases. Database Search Strategies. Integrated information retrieval and data submission to nucleotide databases. Sequence formats. NCBI databases.

Topic 2. Pairwise sequence alignments. Dot-Plot. Local and global alignments. Sequence alignment and dynamic programming. Substitution Matrices: identity and similarity. Scores, gaps and gap penalties.

Topic 3. Sequence Similarity Search. Heuristic algorithms. Bioinformatics tools for sequence similarity searching in sequence databases: BLAST and FASTA strategies. Types of BLAST searches and their applications. DNA or protein annotation by homology based search tools.

Topic 4. Multiple sequence alignments. Progressive method of multiple alignments. Distance matrices. Applications of multiple sequence alignment. Position-specific weight matrices.

Topic 5. Introduction to programming for task automation in bioinformatics. The standard bioinformatic analysis. Programming languages. Variables. Libraries.

Topic 6. Gene and protein domain annotation. *Ab Initio* gene prediction. Protein domain annotations with InterProScan. Functional annotations using the Gene Ontology.

Topic 7. Comparative Genomics and Molecular Phylogenetic Reconstruction. Phylogenetic footprinting/shadowing. Identifying orthologs and paralogs. Synteny. Biological evolution. Molecular phylogenetic. Methods of phylogenetic inference (UPGMA, Neighbor-Joining). Phylogenetic reconstruction: Examples.

Topic 8. Genetic Variation and Natural Selection. Types of genetic variation. Neutral theory of molecular evolution. Test of the neutral model of evolution (Ka/Ks). Examples of natural selection.

Topic 9. Big challenges of Bioinformatics in the Genomic Era. Sequencing, assembly and annotation. Challenges in Bioinformatics.

Topic 10. Proteins: Sequence Analysis. The sequence-structure-function relationship. Primary sequence database of protein. Sequence-based analysis of proteins and prediction of sub-cellular localization.

Topic 11. Proteins: Functional Analysis. Function prediction. Remote homology detection. Tools and resources for identifying protein families, domains and motifs. Secondary and integrated databases.

Topic 12. Proteins: Structural Analysis. The protein data bank (PDB). Searching for structural homologues. Prediction of structural features. Modeling of 3D Structures. Structural Classification of Proteins.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Computer practices	27	1.08	2, 3, 4, 14
Lectures	25	1	2, 3, 14
Type: Supervised			
Mentoring	3	0.12	3, 4
Type: Autonomous			
Completion of questionnaires	10	0.4	2, 3, 4, 14

	Hours	ECTS	
Individual reading	10	0.4	2, 3, 14
Individual study	40	1.6	2, 3, 14
Literature search	4	0.16	13, 12, 2, 3, 4, 14
Solving problems and preparing reports in collaborative groups	25	1	13, 12, 5, 1, 2, 6, 11, 10, 9, 7, 8, 3, 4, 14

The teaching methodology includes two types of differentiated activities: Lectures and practical sessions in the computer classroom. The learning will also have individual and/or collective mentoring of students that will serve as support to solve more specific problems or those requiring it for its complexity or difficulty.

<u>Lectures</u>

Lectures will address the basic ideas of the different topics and will also increase student motivation to participate actively. Lectures will motivate students to expand and confront autonomously the acquired knowledge as a personal work.

<u>Computer practices</u>

These practices are organized based on problems proposed by teachers that should be solved using different bioinformatic tools and analysis. These activities are of obligatory attendance. To speed up these classes, students have at their disposal some video tutorials developed by the professors of the subject that facilitate to carry out routine procedures such as database searches and the use of some programs.

<u>Mentoring</u>

Individual or small group tutorials to solve questions related to the subject. This type of activity will be carried out at the request of the students.

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

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Continuous assessment (End-of-unit tests)	20	0	0	2, 11, 7, 8, 3, 4, 14
Midterm Exam 1 (theoretical-practical contents)	20	2	0.08	2, 3, 4, 14
Midterm Exam 2 (theoretical-practical contents)	20	2	0.08	2, 3, 4, 14
Midterm Exam 3 (theoretical-practical contents)	20	2	0.08	2, 3, 4, 14
Problem-solving in groups	20	0	0	13, 12, 5, 1, 2, 6, 11, 10, 9, 7, 8, 3, 4, 14

The evaluation schedule is organized into four main assessment activities and there will also be a reassessment test and an optional activity to get a higher mark. The success in meeting the course learning objectives will be evaluated as follows:

<u>Main assessment activities</u>

Midterm exams (60%).

- Midterm exam 1. Weight 20%.
- Midterm exam 2. Weight 20%.
- Midterm exam 3. Weight 20%.

Midterm exams are combined tests that can count on theoretical and/or practical questions, combining multiple-choice questions, written answer questions and/or problem solving.

During the partial assessments, the final retake and/or grade improvement exam and the single assessment, the use of chat or generative AI assistants will not be permitted.

None of the assessment activities will account for more than 50% of the final mark.

Each of the three exams requires a minimum grade of 3,5 points (out of 10) in order to pass the course. In addition, a minimum grade of 5.0 is required on the average of the three partial exams.

Continuous assessments (40%).

Throughout the course the teachers will pose problems or questions related to the subject taught (or with new content not necessarily introduced by the teachers) that the students will have to solve in the form of tests or sporadic deliveries. There will be two different types of assessments: solving-problem in groups (integrative problem) with periodical deliveries, and continuous assessment of contents through individualquestionnaires at the end of each unit.

- Problem-solving in groups (20%).

This integrative problem will consist in the resolution of a problem that will include questions related to the different thematic blocks presented during the theoretical andpractical classes.

This integrative problem will be solved autonomously in groups of 3-4 students. The teaching staff will supervise the work and solve doubts and general questions about the strategies to solve problem.

The students will deliver partial results on this problem to the teachers following established guidelines on content, presentation format and deadlines.

This activity requires a minimum grade of 5 points (out of 10) in order to pass the course.

- End-of-unit tests (20%).

Tests of combined multiple-choice, numerical and/or short-answer questions to recapitulate worked contents in each unit. A Moodle platform will be used for questions with feedback. The non-execution of any of the assessment activities is a zero in that activity.

This activity requires a minimum grade of 5 points (out of 10) in order to pass the course.

- Computer classroom practices. They can subtract up to 1 point from the final grade.

This activity is compulsory and the absence without justification or non-profit of the activity may substract up to 1 point from the final grade of the subject.

The continuous nature of this assessment means that the subject cannot be evaluated unless there is a minimum participation (attendance) in 50% of the proposed sessions.

Reassessment attempt

To be eligible for the retake process, the student should have beenpreviously evaluated in a set of activities equaling at least two thirds of the final score of the course.

Students will have the opportunity to retake partial exams 1, 2, and 3 individually if any of them receive a score below 3.5 points. If the retaken exam score is equal to or greater than 3.5, it will be averaged with the passing grades of the other exams. If all three partial exams score above 3.5 but the average of the three is still below 5.0, the exam with the lowest score must be retaken. If, after retaking, any individual exam does not reach a minimum of 3.5 points, or if the average of all three exams remains below 5.0, the course will not be passed.

The qualification obtained for the End-of-unit tests can be retaken provided that the number of activities carried out is greater than or equal to 50% of the programmed ones. Note however that the grade obtained for the integrative problem cannot be retaken.

Getting a higher mark

In order to get a higher mark, those students who have passed the midterm exams 1, 2 and 3 may opt for a final test. This test will include the whole subject. It is not possible to get a higher grade through a written work or other types of activities, or to get a higher grade for the continuous assessment activities.

Exam difficulty level will correspond to the objectives of the subject and, therefore, may be higher than the midterm exams.

The student who takes this exam renounces the previous notes and therefore, the grade of this test will be the one that will prevail in the final grade even if it is lower than the ones obtained in the midterm exams. The new grade obtained cannot be used to obtain "honors".

Calculation of Final Grade

Final grade = [(Midterm exam 1 x 0.20) + (Midterm exam 2 x 0.20) +(Midterm exam 3 x 0.20) + (Integrative problem x 0.20) + (End-of-unit tests x 0.20)]

Passing the course

Overall, in order to successfully pass this course, the student must get a minimum final grade of 5 points (out of 10) and all the main assessment activities have been passed (partial exams, end-of-unit tests and the integrative problem).

Not evaluable

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

Single assessment

For those students who choose the single assessment system, this will consist of a unique written test in which the contents of the entire program of the subject will be assessed. The test may consist of multiple choice questions, short questions and problems to develop. The grade obtained in this synthesis test will account for 80% of the final grade for the subject. The single assessment test will coincide with the date of the last assessment test. As regards the integrative problem (20% of the final mark), the students will work with a team as in the continuous evaluation system, and the delivery of the work will be within the period indicated at the beginning of the subject. For the single assessment option, the same system for retake and review of the final grade and the same criteria to pass as for the continuous assessment system will be applied.

Bibliography

- Claverie, J-M. & Notredame, C. 2007 (2nd ed.). Bioinformatics for dummies. Hoboken, NJ; Wiley, cop.
  https://bibcercador.uab.cat/permalink/34CSUC_UAB/cugbhl/alma991010022259706709
- Lesk, Arthur M. 2019 (5 ed.). Introduction to bioinformatics. Oxford University Press.
  https://bibcercador.uab.cat/permalink/34CSUC_UAB/cugbhl/alma991010637336206709
- Cristianini, N. Y M. W. Hahn. 2007. Introduction to Computational Genomics. A case studies approach.
  Cambridge Univ. Press.
  https://bibcercador.uab.cat/permalink/34CSUC_UAB/cugbhl/alma991010750435106709
- Samuelsson, T. 2012. Genomics and Bioinformatics. Cambridge Univ. Press.
  https://bibcercador.uab.cat/permalink/34CSUC_UAB/cugbhl/alma991010751701806709
- Xiong, J. 2006. Essential bioinformatics. Cambridge Univ. Press.
  https://bibcercador.uab.cat/permalink/34CSUC_UAB/1c3utr0/cdi_globaltitleindex_catalog_348692974

Software

- BLAST (NCBI): (web interface) Program to search databases for DNA and protein sequences through local alignments. https://blast.ncbi.nlm.nih.gov/Blast.cgi
- Python i Biopython: (local installation) Programming languages. Installation via Anaconda (for Biopython "conda install -c conda-forge biopython" from Anaconda's terminal).
  https://www.anaconda.com/products/individual
- Artemis: (local installation) Genomic browser and annotation tool. https://www.sanger.ac.uk/tool/artemis/
- Artemis Comparison Tool (ACT): (local installation) Displays pairwise alignments between two or more genomic sequences. https://www.sanger.ac.uk/tool/artemis-comparison-tool-act/
- MEGA X: (local installation) Integrated tool for conducting phylogenetic analysis.
  https://www.megasoftware.net/
- DnaSP v.5: (local installation) Analysis of DNA polymorphisms using data from both a single locus or from several loci. http://www.ub.edu/dnasp/index_v5.html
- Other bioinformatics programs and biological databases available from its web interface.

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	131	Catalan/Spanish	second semester	afternoon
(PLAB) Practical laboratories	132	Catalan/Spanish	second semester	afternoon
(PLAB) Practical laboratories	133	Catalan/Spanish	second semester	afternoon
(PLAB) Practical laboratories	134	Catalan/Spanish	second semester	afternoon
(TE) Theory	13	Catalan/Spanish	second semester	morning-mixed