UAB
Universitat Autònoma de Barcelona

Function of Biomolecules in Health and Illness

Code: 42888
ECTS Credits: 9

2024/2025

Degree	Type	Year
4313772 Advanced Biotechnology	OT	0
4313794 Biochemistry, Molecular Biology and Biomedicine	OT	0

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Teaching groups languages

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

Prerequisites

The requirements for the Master's degree. The classes will be mostly in Catalan, but they will also be taught in Spanish depending on the faculty. Classes could be conducted in English if requested by the students with sufficient advance notice, and if there is consensus within the student group and with the professor.

Objectives and Contextualisation

Upon completion of the module, the student will be able to:

1. Plan experiments for the identification, expression, purification, and functional characterization of biomolecules.
2. Analyze the structure and function of proteins using bioinformatics techniques.
3. Relate structural and functional changes in biomolecules to pathologies.
4. Select and apply methodologies for the design of enzyme inhibitors.
5. Identify and characterize enzyme inhibitors as drugs.
6. Utilize enzymatic technology for biomedical and biotechnological applications.
7. Recognize biomolecules associated with human pathologies and use them as therapeutic targets.
8. Associate specific diseases with the accumulation of misfolded proteins.
9. Understand the molecular basis of diseases caused by dynamic mutations and epigenetic changes.
10. Assess the functional role of membrane lipids and their involvement in specific pathologies.
11. Familiarize themselves with the main techniques and facilities in a reference clinical biochemistry laboratory.

    Competencies

    Advanced Biotechnology

    Apply techniques for modifying living organisms or parts thereof to improve pharmaceutical and biotechnological processes and products, or to develop new products. (Specialization in Molecular and Therapeutic Biotechnology)

    Ability to synthesize, analyze alternatives, and engage in critical debate.

    Integrate the content of metabolic pathways in living organisms under normal, pathological, or exogenously modified conditions (Specialization in Molecular and Therapeutic Biotechnology).

    Apply acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.

    Effectively communicate their conclusions, as well as the knowledge and ultimate reasons underlying them, to specialized and non-specialized audiences in a clear and unambiguous manner.

    Possess learning skills that enable them to continue studying, largely through self-directed and autonomous work.

    Possess knowledge that provides the foundation or opportunity for originality in the development or application of ideas, often in a research context. Utilize and responsibly manage bibliographic information and computer resources related to biotechnology.

    Biochemistry, Molecular Biology, and Biomedicine

    Analyze research results to obtain new biotechnological or biomedical products and transfer them to society.

    Analyze and accurately interpret the molecular mechanisms operating in living organisms and identify their applications.

    Apply techniques for modifying living organisms or parts thereof to improve pharmaceutical and biotechnological processes and products, or to develop new products.

Develop critical reasoning within the field of study and in relation to the scientific or business environment. Identify and utilize bioinformatic tools to solve problems related to biochemistry, molecular biology, and biomedicine.

Integrate content in biochemistry, molecular biology, biotechnology, and biomedicine from a molecular perspective.

Apply acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.

Effectively communicate their conclusions, as well as the knowledge and ultimate reasons underlying them, to specialized and non-specialized audiences in a clear and unambiguous manner.

Possess learning skills that enable them to continue studying, largely through self-directed and autonomous work.

Possess knowledge that provides the foundation or opportunity for originality in the development or application of ideas, often in a research context.

Utilize and manage bibliographic information and computer resources related to biochemistry, molecular biology, or biomedicine. Utilize scientific terminology to argue research results and effectively communicate them orally and in writing.

Competences

Advanced Biotechnology

- Apply techniques for modifying living beings or parts of these in order to improve pharmaceutical and biotechnological processes and products or develop new products. (Specialisation in molecular and therapeutic biotechnology)
- Communicate and justify conclusions clearly and unambiguously to both specialist and non-specialist audiences.
- Continue the learning process, to a large extent autonomously.
- Integrate the contents of the metabolic paths of living beings in normal conditions, pathological conditions, or conditions that are modified exogenously (specialisation in molecular and therapeutic biotechnology)
- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Synthesise, weigh up alternatives and engage in critical discussion.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
- Use and manage bibliography and IT resources related to biotechnology responsibly.

Biochemistry, Molecular Biology and Biomedicine

- Analyse and correctly interpret the molecular mechanisms operating in living beings and identify their applications.
- Analyse research results to obtain new biotechnological or biomedical products to be transferred to society.
- Apply techniques for modifying living beings or parts of these in order to improve pharmaceutical and biotechnological processes and products or develop new products.
- Communicate and justify conclusions clearly and unambiguously to both specialist and non-specialist audiences.
- Continue the learning process, to a large extent autonomously.
- Develop critical reasoning within the subject area and in relation to the scientific or business context.
- Identify and use bioinformatic tools to solve problems in biochemistry, molecular biology and biomedicine.
- Integrate contents in biochemistry, molecular biology, biotechnology and biomedicine from a molecular perspective.

- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
- Use and manage bibliography and IT resources related to biochemistry, molecular biology or biomedicine.
- Use scientific terminology to account for research results and present these orally and in writing.

Learning Outcomes

1. Analyse research results to obtain new biotechnological or biomedical products to be transferred to society.
2. Communicate and justify conclusions clearly and unambiguously to both specialist and non-specialist audiences.
3. Continue the learning process, to a large extent autonomously.
4. Describe processes and methodologies for designing or transforming biomolecules for application in therapy.
5. Descriure els processos i les metodologies per al disseny o transformació de biomolècules per a la seva aplicació terapèutica.
6. Develop critical reasoning within the subject area and in relation to the scientific or business context.
7. Identificar mecanismes moleculars responsables de malalties.
8. Identificar molècules que intervenen en funcions biològiques importants i la seva variació en situacions de malaltia.
9. Identify molecular mechanisms responsible for diseases.
10. Recognise the molecular mechanisms of important functions in biomedicine.
11. Reconèixer els mecanismes moleculars de funcions rellevants en biomedicina.
12. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
13. Synthesise, weigh up alternatives and engage in critical discussion.
14. Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
15. Use and manage bibliography and IT resources related to biochemistry, molecular biology or biomedicine.
16. Use and manage bibliography and IT resources related to biotechnology responsibly.
17. Use bioinformatic procedures to analyse the active centre of enzymes and design drugs.
18. Use scientific terminology to account for research results and present these orally and in writing.
19. Utilitzar procediments bioinformàtics per a l'anàlisi del centre actiu dels enzims i el disseny de fàrmacs.

Content

Block 1: Identification, acquisition, and purification of biomolecules. Functional characterization.

Practical concepts for protein purification.

Methods for identifying substrates or potential inhibitors, and detecting enzymatic activity.

Practical considerations for enzymatic assays. Applied aspects of enzyme kinetics.

Identification of functional regions of enzymes using bioinformatics tools. Practical session in the computer lab.

Structural and functional analysis of enzyme inhibitors that act as drugs. Practical session in the computer lab.

Drug repositioning: Identification and development of new uses for existing drugs.

Block 2: Enzymes associated with human pathologies. Diagnostic and therapeutic applications.

Enzymes of retinoid metabolism. Associated pathologies.

Urea cycle disorders. Biochemical and computational approaches to evaluate the cause of the pathology.

Enzymes that modify chromatin and their role in human pathologies.

Enzyme replacement therapy. Enzyme activators. Pharmacoperones or pharmacological chaperones. Therapeutic applications.

Enzymes and nanomedicine. Enzyme encapsulation. Controlled drug release. Role of infectious proteins in degenerative diseases.

Strategies for treating lysosomal diseases: enzyme, cell, and gene therapy. Proteases and protease inhibitors. Biomedical applications and strong binding kinetics.

Yeast as a model organism. Three applications in biomolecule characterization: protein-lipid interactions, protein-protein interactions, and genetic interactions.

Block 3: Conformational diseases.

Proteostasis and conformational diseases.

Prions and related diseases.

Therapies in development for conformational diseases: Introduction to conformational diseases. Light chain amyloidosis. Alzheimer's disease.

Block 4: Membrane lipids in Biomedicine.

Role of lipids in various functions and dysfunctions of biomembranes: dynamics of lipid microdomains (lipid rafts, etc.); endocytosis and exocytosis; oxidative stress; apoptosis. Study techniques.

Block 5: Visits to the Clinical Laboratories Service at the Consorci Corporatiu Sanitari Parc Taulí (Sabadell).

Visit to the genetics, biochemistry, immunology, microbiology, and hematology laboratories.

Block 6: In silico strategies for pharmacological identification.

Identification of pharmacophores against a specific protein involved in antibiotic resistance.

In silico screening through molecular docking.

Molecular dynamics and affinity energy calculations between molecules.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Oral presentation	5	0.2	1, 5, 6, 7, 8, 11, 18
Practical activities in the computer classroom	8	0.32	8, 10, 11, 19
Theory classes	38	1.52	5, 7, 8, 11, 19
Visit to clinical laboratories	4	0.16	6, 9, 12
Type: Supervised			
Preparation and presentation of an individual work	10	0.4	2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 15, 17, 18

Type: Autonomous			
Independent work of the student	77	3.08	1, 3, 6, 12, 13, 14, 16, 18

The module consists of theoretical classes, computer lab practical classes, a visit to a reference Clinical Biochemistry laboratory, and a seminar presentation by the student. The organization and teaching methodology for these educational activities are described below.

Theory classes:

The content of the theory program will be primarily delivered by professors in the form of lectures with audiovisual support. The presentations used by the professor in class will be made available beforehand on the Virtual Campus of the subject. It is recommended that students have access to this material as a support for their classes. It is advised that students regularly consult the recommended books listed in the Bibliography section of this teaching guide to consolidate and clarify, if necessary, the content explained in class. It is also advisable for students to use the links provided in the presentations of different topics, which contain videos and animations related to the processes explained in class.

Computer lab practical classes:

Students will be directly called to the classroom for the development of the session. The work will be individual, and it will be important for the student to have prior knowledge of the software to be used.

Visit to a reference Clinical Biochemistry laboratory:

The session will take place at the Clinical Analysis Laboratory of the Parc Taulí Hospital in Sabadell, where the student will receive explanations about the functioning of all the facilities and the methodologies used by healthcare professionals. After the visit, a multiple-choice knowledge test will be conducted.

Seminar presentation:

Each student will be required to give a seminar presentation.

The student will prepare a seminar on a topic agreed upon with a tutor professor and will present it publicly in class using audiovisual means.

Preparation tutorials for the seminar:

There will be a group tutorial session led by the module coordinator to distribute the seminar topics and propose the general organization of the material to be presented. Students may also have individual tutorials with professors directly involved in the chosen topic to guide them in the preparation of the material.

Note: 15 minutes of a class, within the schedule established by the institution/program, will be reserved for students to complete evaluation surveys of the faculty's performance and evaluation of the subject/module.

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

Attendance and active class participation	10%	38	1.52	2, 4, 7, 8, 9, 10, 11, 12, 14, 17, 19
Continuous assessment	30%	30	1.2	2, 3, 4, 7, 9, 11, 12, 14, 15, 16, 17, 18
Presentation of a seminar	20%	5	0.2	1, 2, 3, 6, 12, 13, 14, 15, 16, 18
Theory exams	40%	10	0.4	2, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18

- Attendance and active participation in class:

Bibliography

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Software

Pymol vs 2.5

Autodock Vina

Gromacs

VMD (Visual Molecular Dynamics)

https://www.uniprot.org/ (online database)

https://www.rcsb.org/ (online database)

https://www.ebi.ac.uk/Tools/msa/clustalo/ (online tool)

https://swissmodel.expasy.org/ (online tool)

https://www.ebi.ac.uk/pdbe/emdb/empiar/ (online database)

Language list

Name	Group	Language	Semester	Turn
(PLABm) Practical laboratories (master)	1	English	annual	afternoon
(SEMm) Seminars (master)	1	Catalan/Spanish	annual	afternoon
(TEm) Theory (master)	1	Catalan/Spanish	annual	afternoon