Universitat Autònoma de Barcelona

2017/2018

Structure and Function of Biomolecules

Code: 100758
ECTS Credits: 6

Degree	Type	Year	Semester
2500250 Biology	FB	1	2

Contact

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Use of languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Other comments on languages

Most of the teaching materials used will be written in English and published in the Campus Virtual

Prerequisites

There are no official prerequisites. However, it is assumed that the student has assimilated the concepts acquired during the first term, particularly those contained in the subjects of Chemistry and Cell Biology, such as those related to chemical functional groups, chemical equilibrium, basic thermodynamics, biological membranes and cellular compartmentalization.

Objectives and Contextualisation

The course Structure and Function of Biomolecules is the first part of the subject "Biochemistry" in the Biology degree; it covers the structural and functional characteristics of biomolecules from a point of view which is basic and simple but also with the necessary depth required for further use, mainly related to the structure and function of enzymes and the bioenergetics concepts that will be used in the second part of the subject to be taught in the third term under the name Biosignalling and Metabolism. Similarly, the concepts on the structure and function of biomolecules are essential for the understanding of more specialised courses in the Biology degree.

Objectives:

- To understand, based on previously acquired chemistry knowledge, the fundamental structural characteristics of biological molecules, being able to draw conclusions about their stability, functionality and ability to replicate structures.
- To acquire the conceptual basis of bioenergetics processes as a primer to the second part of the subject Biochemistry, dedicated to metabolism.
- To understand the kinetics of enzymatic action in the context of the study of biological reactions and their metabolic relationships.
- To understand the basic methods of purification, characterization, structural analysis of biomolecules and recombinant DNA methodologies.

Content

THEORY

1. Elements, molecules and the physical environment of living beings.

The chemical logic of biological processes. Chemical elements in living species. Biomolecules. Levels of structural organization of biomolecules. Biological importance of water. Non-covalent interactions in water. Ionization of water, ionic balance and buffer systems.

2. Principles of bioenergetics.

Energy transformations in living organisms and the laws of thermodynamics. Free energy and equilibrium constant. Common biochemical reactions. Transfer of phosphate groups and ATP. Oxidation-reduction reactions.

3. Proteins: primary structure and biological functions.

Classes of proteins and their functions. Structure and properties of amino acids. Stereoisomerism and acid - base behavior. Peptides and peptide bond. Analysis of the amino acid composition and protein sequencing methods.

4. Three-dimensional structure of proteins.

General concepts. Secondary structure. a helices and β sheets. Tertiary structure. Fibrous proteins. Globular proteins. Protein folding: factors that determine it. Molecular chaperones. Introduction to conformational diseases. Protein structure prediction. Quaternary structure. Introduction to techniques for purification and characterization of proteins.

5. Structure-function relationship and evolution of proteins.

Storage and transport of oxygen: hemoglobin and myoglobin. Allosterism and cooperativity in hemoglobin. Myoglobin and hemoglobin s examples of protein evolution. Using protein sequences for the analysis of evolutionary relationships.

6. Biological catalysts.

What they are and how they work. Enzyme cofactors. Classification and nomenclature of enzymes. Effects of catalysts in chemical reactions. Examples of enzymatic mechanisms. Enzyme kinetics: the concept of initial velocity; Michaelis-Menten model. Enzyme inhibition. Regulation of enzyme activity: (inhibition), allosterism, covalent modification. Biomedical and biotechnological applications.

7. Carbohydrates.

Types of carbohydrates and their functions. Monosaccharides: Description and properties. Derivatives of monosaccharides. Glycosidic bond. Oligosaccharides. Structural and storage polysaccharides. Glycoconjugates: glycoproteins, proteoglycans, and glycolipids. Carbohydrates as "informative" molecules.

8. Nucleic acids.

Basic concepts. Nucleotides. Primary structure of nucleic acids. Secondary structure: Watson and Crick model and alternative structures. Tertiary structure: DNA supercoiling and tRNA conformation. DNA-protein complexes: chromosome organization.

9. Structural characterization of macromolecules.

Spectroscopic methods and their applications; absorption spectroscopy, fluorescence, circular dichroism, infrared spectroscopy. Mass spectrometry. Determining the three-dimensional structure of macromolecules by NMR and X-ray diffraction.

10. Recombinant DNA.

Brief introduction to nucleic acid metabolism: replication, transcription and translation. Materials and methods for DNA cloning: restriction enzymes, vectors, recombinant protein expression and purification methods. The most common methods of recombinant DNA technology. Applications to the production and modification of proteins. DNA sequencing and genome projects. Some applications of genetic engineering. Genomics and proteomics.

11. Lipids and biological membranes.

Lipid and functions. Lipid storage. Structural membrane lipids. Other lipids with specific biological activity. Lipoproteins. Structure and properties of biological membranes. Membrane proteins. Transport through membranes.

PROBLEMS

This section will be based on a dossier that will be delivered at the beginning of the semester consisting of a series of problems related to the topics developed in the theory lectures. The characteristics of the various parts of the syllabus theory impose a concentration of the problems proposed on certain specific aspects: chemical balance and buffer systems, free energy and equilibrium constant, purification methods and analysis of macromolecules, enzyme kinetics and recombinant DNA.

LABORATORY

Two four-hour sessions:

1- Spectrophotometry as a method for determining the concentration of biomolecules. Preparation of buffer solutions.

2. Liquid chromatography and electrophoresis on SDS-polyacrylamide gels as methods for the analysis and purification of biomolecules.