Universitat Autònoma de Barcelona

Protein Chemistry and Engineering 2016/2017

Code: 100935
ECTS Credits: 6

Degree	Type	Year	Semester
2500253 Biotechnology	OB	3	1

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

Based on an agreement with the students enrolled, part of the theory programme will be given in English

Prerequisites

There are no official prerequisites, but it is assumed that the student has previously acquired enough solid knowledge on subjects like Fundamentals of Chemistry, Organic Chemistry, Biochemistry and Recombinant DNA Technology.

As in most subjects, much of the literature is in the English language, which is also used in the figures projected in theory classes and also for oral communication, when needed.

Objectives and Contextualisation

The course on Protein Chemistry and Engineering belongs to the main subject "Proteins and nucleic acids: structure, function and engineering" of which a part has been taught in the second year of the Biotechnology degree. This course examines the structural and functional characteristics of amino acids, peptides and proteins both from a basic and applied point of view, the methodologies used in their analysis and modification, and their biomedical and biotechnological applications.

Proteins are effector molecules of many biochemical and biological processes, most of which have been studied in the first two years. However, knowledge of their structure and function is crucial to a deep understanding of a number of subjects in the Biotechnology degree. The knowledge acquired in the course of Protein Chemistry and Engineering is complemented by a practical training in the Integrated Laboratory Course 5. The specific objectives are:

- To reach a deeper understanding of the physicochemical characteristics of amino acids and peptides
- To describe and apply methods for the analysis of protein sequences and peptide synthesis.
- To recognize the structural elements, the different complexity levels, the types of protein folding and their capacity to build higher order structures.
- To reach a knowledge on the use of information resources to establish structural classifications of proteins.
- To understand and explain the most common methods for the analysis of the conformation and stability of proteins, including three-dimensional analysis.
- To describe the molecular basis of protein folding, molecular dynamics, post-translational processing and intra- and extracellular protein traffic.

- To establish evolutionary relationships and learn the methods of structural analysis and structure prediction.
- To understand and apply the most common methods for the production and purification of recombinant proteins.
- To design strategies for modifying and optimizing the properties of proteins and to understand the basis for protein design and the methodologies used in these processes.
- To achieve an global vision about the structure-function relationships in proteins and about the application of these biomolecules in medicine, industry and research.
- To integrate the theoretical knowledge in the interpretation of the results of scientific experiments using the appropriate scientific terminology.

Content

THEORY

I. Fundamental properties of amino acids and proteins

Proteins, peptides and their functions in living beings. Structure and physicochemical properties of amino acids. Chemical reactivity. Differential contribution of amino acids to protein properties. Evolutionary relationships.

II. The peptide bond and the sequence polypeptide

Stereochemistry of the peptide bond. Types of natural peptides. Chemical reactivity of peptides. The polypeptide sequence. Strategies for determining the sequence of proteins. Chemical synthesis of peptides; combinatorial libraries.

III. Conformational determinants. Secondary structures

Structural hierarchy. Types of conformation-stabilizing forces. Cooperativity of weak interactions. Determinants of protein folding. Main types of secondary structures.

IV. Structural Classification of Proteins

Supersecondary structures and motifs. Structural domains. Tertiary structure. Domain classification. Conformation and function of fibrous proteins. IDPs- intrinsically disordered proteins.

Structure-function correlation . Examples

General functions of proteins. Enzymatic proteins: examples. Proteins that bind to nucleic acids: examples. Molecular motors: examples. Membrane proteins.

VI. Quaternary structure of proteins

Advantages of quaternary structures. Protomers and subunits. General principles: interfaces, geometries, symmetries. Examples of oligomeric proteins: structure-function and regulation of the activity

VII. Determining the three-dimensional structure of proteins

General methodologies for the structural characterization of proteins. Dissolution analysis: IR, DC, UV-Vis, fluorescence. Analysis in solid phase: X-ray crystallography and cryo-electron microscopy. NMR spectroscopy: 3D structure in solution.

VIII. Folding and conformational dynamics

Protein folding and unfolding: native state and unfolded state. Methods for the analysis of folding. Thermodynamics and mechanistics of the folding process; models that describe it. Folding and aggregation; conformational diseases. Protein folding in vivo: the molecular chaperones. Molecular dynamics of proteins.

IX. Post-translational modifications

Types of post-translational modifications and their functional implications. Transport and associated changes. Limited proteolysis: pre-proteins, zymogens. Examples of regulation by limited proteolysis: coagulation, digestive enzymes. Degradation and protein turnover in vivo.

X. Protein-ligand interaction

Forces involved in protein-ligand association. Methods of study of the interaction. Determination of kinetic and thermodynamic parameters. Designing drugs based on the structure.

XI. Biochemical evolution of proteins

Protein evolutionary relationships. Detection and analysis of homologies; sequential databases; phylogenetic trees. Convergent and divergent evolution; examples. Sequence structure and function. 3D structure prediction; conformational modelling. Evolution of genomes and protein evolution.

XII. Protein engineering: rational design

Rational design: directed mutagenesis as a tool for the analysis and modification of proteins. Examples and applications of protein engineering in the analysis, modification and improvement of the structure, stability,and functionality.

XIII. Protein engineering: directed evolution and de novo synthesis

Directed evolution: random mutagenesis and combinatorial protein engineering methods. Methods for the generation and selection of variants. Examples of redesigned proteins. De novoprotein design - computer algorithms.

Out of the programme scope. XIV. Protein engineering: heterologous production

Goals of the protein engineering and production cycle. General strategies for the heterologous expression of recombinant proteins. Heterologous expression in different organisms; choice of expression systems. Purification methodologies for the analysis of recombinant proteins.

This issue is not part of the program because its contents has already been treated in Recombinant DNA Technology or similar courses.

PROBLEMS

The content of this section will be given in the form of a dossier at the beginning of the semester via the Virtual Campus. It involves a certain amount of problems related to the topics developed in the theory class. The dossier will be updated periodically. The characteristics of the various parts of the theory syllabus make the subjects of the problems class to be concentrated in a limited number of aspects. Thus, the evaluation of problems may vary between partial examinations.