



Universitat de Lleida

DEGREE CURRICULUM  
**STRUCTURAL BIOCHEMISTRY**

Coordination: CABISCOL CATALA, ELISA

Academic year 2020-21

**Subject's general information**

<b>Subject name</b>	STRUCTURAL BIOCHEMISTRY			
<b>Code</b>	101536			
<b>Semester</b>	PRIMER QUADRIMESTRE			
<b>Typology</b>	Degree	Course	Character	Modality
	Bachelor's Degree in Biomedical Sciences	1	COMMON	Attendance-based
<b>Course number of credits (ECTS)</b>	6			
<b>Type of activity, credits, and groups</b>	<b>Activity type</b>	PRALAB	PRAULA	TEORIA
	<b>Number of credits</b>	1.5	1.5	3
	<b>Number of groups</b>	2	2	1
<b>Coordination</b>	CABISCOL CATALA, ELISA			
<b>Department</b>	BASIC MEDICAL SCIENCES			
<b>Teaching load distribution between lectures and independent student work</b>	Lectures/seminars/laboratory sessions: 60 h Independent student work: 90 h			
<b>Important information on data processing</b>	Consult <a href="#">this link</a> for more information.			
<b>Language</b>	Classes are taught either in Catalan or Spanish Additional information: Catalan, Spanish and English			
<b>Distribution of credits</b>	TOTAL: 6 credits (ECTS) 1. Master class: 3.1 2. Seminars / problems: 0.9 3. Bioinformatic work: 1.3 4. Laboratory sessions (4 small groups): 0.7			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CABISCOL CATALA, ELISA	elisa.cabiscol@udl.cat	4,2	
EGEA NAVARRO, JOAQUÍN	joaquim.egea@udl.cat	3	
PEDRAZA GONZALEZ, NIEVES	neus.pedraza@udl.cat	1,8	

## Subject's extra information

### Introduction to the subject and contextualization within the Biomedical Sciences degree

This first course subject aims to give basic knowledge of the most important biomolecules of living beings which form the basis of the structure and functioning of cells, tissues and human organs. Most relevant proteins, carbohydrates and lipids are studied, as well as the pathological consequences induced by alteration of one of these structures. In addition, the student will learn the mechanisms of function and regulation of the enzymes and the structure and function of the vitamins.

It is complemented with subjects such as Cell Biology and the General and Organic Chemistry of the first semester (first year).

It is especially relevant to understand the Metabolic Biochemistry, Human Physiology, Cellular Biology and Molecular Biology of the first year, as well as Proteomics of the second year.

## Learning objectives

### Academic objectives of the subject

With regard to **knowledge**, the student that exceeds the subject must be able to:

- Know the basic scientific terminology applied to biochemistry.
- Know the main physiological buffers and their physiological importance
- Recognize and classify the most important biomolecules that make up living organisms
- Understand the primary, secondary, tertiary and quaternary structure of the proteins
- Recognize the structure and function of the most important fibrous and globular proteins in humans
- Understand the basic concepts of enzymology, the regulation of enzymatic activity and apply them to the cellular functioning and the entire organism
- Learn to distinguish the most important complex carbohydrates and their physiological role
- Understand and differentiate membrane lipids and energy storage
- Recognize and differentiate the vitamins, their main function and the consequences of their deficits

At the level of the **procedure**, the student who passes the subject must be able to:

- Solve problems related to the biochemistry of human beings

Know how to use the basic elements of a biochemistry laboratory  
Understand the concepts of concentration and know how to apply the dilution parameters  
Know how to use spectrophotometric techniques to calculate parameters of biochemical relevance  
Analyze and compare the experimental results and assess their importance and their limitations.  
Work as a team in the resolution of problems and in the laboratory  
Know how to collect basic information about a topic, elaborate a summary and explain it clearly to colleagues  
Understand and critically evaluate basic scientific information related to human biochemistry

## Competences

### Competences Curriculum

- To understand the structure and function of biomolecules
- To know the mechanisms of synthesis and degradation of biomolecules.
- To integrate the molecular and metabolic bases of the functioning of the human organism in relation to human pathology and therapeutic techniques.
- To know, evaluate critically and know how to use the technologies and sources of clinical and biomedical information, to obtain, organize, interpret and communicate clinical, scientific and health information
- Handle material and basic laboratory techniques

## Subject contents

### THEORETICAL CURRICULUM - LECTURES (31h)

#### Introduction to Structural Biochemistry (1h)

#### Topic 1. Composition of living matter. Water and shock absorber systems (3h)

- Establishment of living beings
- Structure, characteristics and properties of water
- Biological importance of water. Distribution in the human organism
- Concept of pH. Buffer solutions of biological relevance
- Metabolic and respiratory alterations of the acid-base balance

#### Topic 2. Proteins (5h)

- Structure, nomenclature and properties of amino acids.
- Primary structure of proteins. The peptide bond.
- Secondary structure: alpha helix and beta sheet
- Concept of tertiary structure. Structural motifs and domains.
- Quaternary structure: oligomeric protein
- Fibrous proteins: keratins and collagen.
- Globular proteins: myoglobin and hemoglobin.
- Plasma proteins
- Native structure and denaturation
- Techniques of protein study: X-ray diffraction, crystallography, ..

#### Topic 3. Enzymology (7h)

- Nature, nomenclature and classification of enzymes.
- Introduction to enzymatic catalysis: activation energy.
- The active center and union models ES
- Catalytic strategies. Examples
- Holoenzymes and apoenzymes. Concept of prosthetic group and coenzyme
- Cofactors: metalloproteins
- Michaelis-Menten kinetic model. Linearizations.  $K_m$  and  $V_{max}$

- Catalytic efficiency:  $K_{cat}$
- Multiple substrate reactions
- Effect of pH, temperature and ionic strength on enzymatic activity
- Applications of enzymes in the industry
- Concept of isoenzyme
- Non-protein biocatalysts: ribozymes

## Topic 4. Enzyme regulation (4h)

- Irreversible regulation: zymogens
- Reversible regulation: phosphorylation, acetylation, ..
- Cooperativity
- Allosterism
- Enzymatic inhibition: reversible and irreversible

## Topic 5. Carbohydrates (4h)

- General characteristics and classification
- Monosaccharides: structure, properties, derivatives and biological interest
- Disaccharides. The glycosidic link. Disaccharides relevant to human nutrition
- Oligosaccharides. Structure, properties and biological interest
- Store and structural polysaccharides. Glycogen, starch and cellulose
- Glycoproteins Proteoglycans, glycosaminoglycans and associated pathologies

## Topic 6. Lipids (4h)

- General characteristics of lipids. Function and classification
- Fatty acids. Physicochemical properties and nomenclature
- Storage lipids: triacylglycerides
- Membrane Lipids: Phosphoglycerides and sphingolipids
- Steroids: cholesterol, cholesterol esters, bile acids and salts and steroid hormones
- Icosanoids: prostaglandins, thromboxanes and leukotriens

## Topic 7. Vitamins (3h)

- Water-soluble vitamins
- Liposoluble vitamins

## SEMINARS, PROBLEMS AND LABORATORY (29h)

### Laboratory practices: (7h)

#### Lab session 1. Buffer solutions and pH (2h)

- Learn how to use a pH meter
- Prepare different buffers and measure the pH to know the concepts of acid, base, pH, pKa, buffer, ...
- Analyze how the pH values vary by varying the ratio of the acid and its conjugate base
- Compare how the addition of a base or a strong acid affects a buffer solution
- Comparison and discussion of the results

#### Lab session 2. Determination of the protein concentration in human serum (2 h)

- Determination of the concentration of total serum protein by spectrophotometric techniques. The Biuret method.
- Preparation of a straight line graph with serum albumin.
- Comparison and discussion of the results

#### Lab session 3. Determination of the kinetic constants of an enzyme (3 h)

- Study of the alcohol dehydrogenase activity. Catalyst reaction and activity quantification methods.

- Calculation of enzymatic activity and specific activity.
- Determination of  $V_{max}$  constant and apparent  $K_m$ . Calculation of the turnover number ( $K_{cat}$ ) and the catalytic efficiency ( $K_{cat}/K_m$ )
- Comparison and discussion of the results

## **Bioinformatic work:** (13h)

- Session 1: Protein structure: visualization of proteins through RasMol (2h)
- Session 2: Uniprot: analysis of protein sequences. Protein Data Bank. (2h)
- Session 3. Protein structure: Chimera (2h)
- Sessions 4-6: Student presentations of the assigned protein (6h)

## **Problems / Seminars** (9h)

- **Seminars:** Spectrophotometry,... (3h)
- **Problems** (6h): List of biochemical problems of a variety of topics: preparation of solutions, dilutions, quantification of concentrations by spectrophotometry, buffers and pH calculation, enzymology, bioenergetics ...

## Methodology

### **THEORETICAL CURRICULUM - LECTURES** (31 h)

Master classes (1GG): the fundamental content of the subject will be explained, highlighting the most relevant aspects for its training. Whenever possible, pathological aspects related to human health will be highlighted. They will be done with all the students and they are not obligatory.

### **SEMINARS AND PROBLEMS** (9 h)

**Seminars:** to explain the basics of spectrophotometry, how a spectrophotometer works and the different types. The role of spectrometry in research, as well as in clinical biochemistry and industry will be explained.

**Problems:** a list of biochemical problems based on preparation of solutions, calculation of dilutions, quantification of concentrations by spectrophotometry, preparation of buffers and calculation of pH, enzymology, ...) will be proposed to students to be solved. The solution to the problems will be discussed and, if applicable, the importance in metabolism or human pathologies will be presented and discussed. Assistance is mandatory.

### **BIOINFORMATIC WORK** (13 h)

Students will perform a series of computer exercises in order to apply and work on some theoretical concepts that will be explained previously about the use of protein databases and protein structure. In pairs, students will make a written essay and an oral presentation related to a protein previously assigned to each one. Compulsory attendance.

RUBRIC (will be valued):

#### **1) The written presentation:**

- 1.1. Structure and content: the information indicated is correct, precise and complete. It is not necessary that the slides contain a lot of text, but enough to understand what is presented.
- 1.2. Text and lexicon: well structured, with no grammatical or spelling errors. The lexicon record must be adequate (scientific)
- 1.3. Iconography: consistency and adequacy of graphics, labels, figure captions or tables, references to text. The slides are clear, the images look good and they are well presented.

#### **2) Oral exposure:**

- 2.1. Presentation: the explanation is clear and orderly and the appropriate terminology is used.
- 2.2. Questions: in the debate phase the questions are adequately answered, using the appropriate scientific language
- 2.3. Time: the duration is adjusted to the indicated time

2.4. Concordance: the oral presentation be consistent with the written presentation.

## **LABORATORY** (7 h)

Three laboratory sessions will be carried out by the students with the goal of knowing main biochemical methodology, being able to correctly use basic elements of a laboratory of biochemistry and basic working patterns to ensure reliability and safety results in the laboratory. Assistance is mandatory.

**It is mandatory for students to bring to all laboratory sessions :**

- White lab coat (UdL)
- Safety glasses
- Gloves
- Mask

They can be acquired at the UdL store (**ÚDELS**). Centre de Cultures i Cooperació Transfronterera – Campus Capponet. Carrer de Jaume II, 67 baixos. 25001 Lleida

Not carrying the EPI described or not complying with the general security regulations detailed below will mean that the student can not access the laboratories or have to leave the same.

### **GENERAL SAFETY RULES IN THE LABORATORY**

- Maintain the place of performance of clean and tidy practices. The work table must be free of backpacks, folders, coats ...
- In the laboratory you can not come with shorts or short skirts.
- Bring closed and covered shoes during the performance of the practices.
- Bring long hair always collected
- Keep the gowns cords to protect against spills of chemical substances.
- Do not wear wide bracelets, pendants or sleeves that can be trapped by the equipment.
- Avoid wearing contact lenses, since the effect of chemicals is much greater if they are introduced between the contact lens and the cornea.
- Do not eat or drink in the laboratory
- Smoking is prohibited within laboratories
- Wash your hands whenever you have contact with a chemical and before leaving the laboratory.
- Follow the teacher's instructions and consult any doubts about security

### **SPECIFIC RULES FOR COVID19**

- They will be properly informed, before carrying out laboratory sessions, depending on the health situation and the regulations that arise.

## **Development plan**

### **THEORETICAL CURRICULUM - LECTURES** (31 h)

Master classes of one group of 50-55 min, spread throughout the semester.

- 17h will be taught in person: classes 1 to 10 and classes 16 to 22.
- 14h will be taught online, through synchronous classes (videoconference)

### **SEMINARS AND PROBLEMS** (9 h)

Seminars and problem sessions of 100 min (2 x 50 min, 10 min rest).

Starting with the spectrophotometry seminar, which is essential for carrying out laboratory sessions, followed by problem sessions.

All hours will be taught online through synchronous classes (videoconference)

## **BIOINFORMATIC WORK (13 h)**

Once the concepts of proteins and enzymes have been presented, students will be introduced to protein databases and the software necessary to analyze tridimensional protein structures in three sessions (2h + 2h + 3h). One specific protein will be assigned to each student. With the information provided in these sessions, a written dossier will have to be performed and hang in the virtual Campus. These sessions will take place in a single group and in virtual format through synchronous classes (videoconference)

In addition, the 2 students (one from group A and the other from group B) who have been assigned the same protein will perform a presentation in pairs of about 5-6 min in front of their classmates (3 sessions of 2 h) with respect to the information obtained from "their" protein, using the Uniprot-Protein Data Base databases and the software for 3D Chimera. These sessions will be face-to-face and in a single group.

## **LABORATORY SESSIONS (7 h)**

Two laboratory sessions of 2 hours and 1 lab session of 3 hours will be carried out, spread throughout the course in parallel to the theoretical concepts necessary to understand the lab sessions are introduced.

They will be face-to-face and will be carried out in small groups that allow the necessary spacing (4 groups of 10-12 people).

**THE POSSIBILITY OF TEACHING THE SCHEDULED FACE-TO-FACE CLASSES WILL ALWAYS BE DEPENDING ON THE PANDEMIC EVOLUTION AND THE REGULATIONS THAT DERIVE FROM IT.**

## Evaluation

### **FIRST PARTIAL TEST: 4 points**

- Written exam with multiple choice questions or similar (T/F, matching pairs, fill de gaps,...) and short answer questions about contents and basic concepts of theoretical concepts and seminars.
- Problems to solve.

### **SECOND PARTIAL TEST: 2.8 points**

- Written exam with multiple choice questions or similar (T/F, matching pairs, fill de gaps,...) and short answer questions about contents and basic concepts of theoretical concepts.

### **BIOINFORMATIC WORK: 2 points**

- Evaluation of the activities carried out: written report and oral presentation

### **LABORATORY SESSIONS: 1.2 point**

- Written exam with short questions and problems related to laboratory sessions



**TUTORIES:** request appointment

DEPENDING ON THE EVOLUTION OF THE COVID 19 PANDEMIC AND IF THE TEACHING STAF BELIEVES IT SUITABLE, CHANGES IN THE TYPE OF EVALUATION CAN BE MADE

**Highest score:** 10 points

- • Fail: <5 points
- • Approved: from 5 to 6.99 points
- • Notable: from 7 to 8.99 points
- • Excellent: > 9 points
- • Excellent-MH: the two best grades with > 9 points

## Bibliography

### **Basic bibliography** (library)

1. Baynes JW, Dominiczak MH. 2019. Bioquímica Médica. 5ª edición. Ed. Elsevier
2. Branden C, Tooze J. 1999. Introduction to protein structure. 2n edition. Garland Publishing
3. Champe PC, Harvey RA, Ferrier DR. 2005. Bioquímica. 3a edición. Ed. Mc Graw-Hill Interamericana
4. Devlin TM. 2010. Bioquímica. Libro de texto con aplicaciones clínicas. 4a edición. Ed Reverté. (7th edition available in english. Wiley-Liss Ed.)
5. Mathews CK, et al. 2013. Bioquímica. 4ª edición. McGraw-Hill Interamericana.
6. Rodwell VW, et al. 2018. Harper's Illustrated Biochemistry. 31th edición. Ed. McGraw-Hill Education
7. Nelson DL, Cox MM. 2018. Lehninger. Principios de Bioquímica. 7a edición. Ed. Omega.
8. Strayer L, Berg J, Tymoczko J. 2018. Bioquímica. 9a edición. Ed. Reverté. (6a edició en català)
9. Strayer L, Berg J, Tymoczko J. 2014. Bioquímica. Curso básico. Ed. Reverté.
10. Teijón y Blanco. 2017. Fundamentos de Bioquímica estructural. 3a edición. Ed. Tébar Flores
11. Voet D, Voet JG, Prat CW. 2016. Fundamentos de Bioquímica. 4a edición. Editorial Médica Panamericana

### **Scientific journals** (library):

- Investigación y Ciencia
- New England Journal of Medicine