Universitat de Lleida

DEGREE CURRICULUM

STRUCTURAL BIOCHEMISTRY

Coordination: CABISCOL CATALA, ELISA

Academic year 2023-24

STRUCTURAL BIOCHEMISTRY 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>STRUCTURAL BIOCHEMISTRY</td></tr>
<tr><td>Code</td><td>101536</td></tr>
<tr><td>Semester</td><td>1st Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Biomedical Sciences</td><td>1</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRALAB</th><th>PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>0.9</td><td>2.1</td><td>3</td></tr>
<tr><td>Number of groups</td><td>3</td><td>2</td><td>1</td></tr>
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<tr><td>Coordination</td><td>CABISCOL CATALA, ELISA</td></tr>
<tr><td>Department</td><td>BASIC MEDICAL SCIENCES</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>Lectures/seminars/laboratory sessions: 60 h

Independent student work: 90 h</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Classes are taught mainly in Spanish, but in some cases, in Catalan
Additional information: English, Catalan, Spanish</td></tr>
<tr><td>Distribution of credits</td><td>TOTAL: 6 credits (ECTS)
1. Master class: 30 h
2. Seminars / problems: 9 h
3. Bioinformatic work: 12 h
4. Laboratory sessions: 9 h</td></tr>
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STRUCTURAL BIOCHEMISTRY 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CABISCOL CATALA, ELISA	elisa.cabiscol@udl.cat	4,1	
EGEA NAVARRO, JOAQUIM	joaquim.egea@udl.cat	3,1	
PEDRAZA GONZÁLEZ, NIEVES	neus.pedraza@udl.cat	1,5	
PORTILLO CARRASQUER, MARTA	marta.portillo@udl.cat	1,2	

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 rellevant 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**, students 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**, students 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:

CB1 That students have demonstrated that they have and understand knowledge in an area of study that is based on general secondary education, and is usually found at a level that, while supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study

CB2 That students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the development and defense of arguments and problem solving within their area of study

CE6. Describe the structure and function of biomolecules

CE7. Describe the mechanisms of synthesis and degradation of biomolecules and their regulation

CE18. Critically evaluate and use clinical and biomedical information technologies and sources to obtain, organize, interpret and communicate clinical, scientific and health information

CE19. Use laboratory material and apply basic laboratory techniques.

Subject contents

THEORETICAL CURRICULUM - LECTURES (30h)

Introduction to Structural Biochemistry (1h)

Topic 1. **Composition of living matter. Water and shock absorber systems** (2h)

- Establishment of living beings
- Structure, characteristics and properties of water
- Biological importanceof 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.
- Mitochondrial and ER localization sequences. NES and NLS sequences
- Quaternary structure
- Isoforms, signal peptides and disordered regions
- Fibrous proteins: keratins and collagen.

- Globular proteins: myoglobin and hemoglobin.
- Plasma proteins. Membrane 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
- Holoenzims and apoenzims. Concept of prosthetic group and coenzyme
- Cofactors: metalloproteins
- Michaelis-Menten kinetic model. Linearizations. Km and Vmax
- Catalytic efficiency: Kcat
- 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 Proteoglicans, 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

LABORATORY PRACTICES: (9h)

Lab session 1. Quality control in the laboratory (2h)

- Importance of experimental repetitions and measurement parameters. Precision and accuracy.
- Recognition of the error in the laboratory work and the variables that may influence it.

- Learn how to use a spectrophotomter and other material from a biochemistry laboratory.
- Comparison and discussion of the results

Lab session 2. 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 3. Determination of the protein concentration in human serum (2h)

- 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 4. Determination of the kinetic constants of an enzyme (3h)

- Study of the alcohol dehydrogenase activity. Catalyst reaction and activity quantification methods.
- Calculation of enzymatic activity and specific activity.
- Determination of Vmax constant and apparent Km. Calculation of the turnover number (Kcat) and the catalytic efficiency (Kcat/Km)
- Comparison and discussion of the results

BIOINFORMATIC WORK (3D structure of proteins): (12h)

- 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 (8h)

- **Seminars (2h)**: Spectrophotometry,..
- **Problems (6h)**: List of biochemical problems of a varity of topics: preparation of solutions, dilutions, quantification of concentrations by spectrophotometry, buffers and pH calculation, enzymology, bioenergetics ...

Methodology

THEORETICAL CURRICULUM - LECTURES (30 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 (8 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 - 3D PROTEIN STRUCTURE (12 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.

Individually, students will make a written assay 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 enought 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 (9 h)

Four 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

They can be adquired at the UdL store (**ÚDELS)**. Centre de Cultures i Cooperació Transfronterera – Campus Cappont. 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

Development plan

THEORETICAL CURRICULUM - LECTURES (30 h)

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

SEMINARS AND PROBLEMS (8 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.

Seminars and problemes will be performed in two groups.

BIOINFORMATIC WORK (12 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 + 2h). 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 2 groups.

In addition, each student will perform a presentation of 5 min in front of all their classmates (3 sessions of 2 h) with respect to the information obtained from the protein assigned, using the Uniprot-Protein Data Base databases and the software for 3D Chimera.

LABORATORY SESSIONS (9 h)

Three 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 carried out in small groups that allow the necessary spacing (3 groups of 15-17 students).

Evaluation

FIRST PARTIAL TEST: 4.1 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: 2.9 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 point

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

TUTORIES: request appointment

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

* The score for each part may vary depending on the content included. The final mark is obtained from the weighted average of all evaluations, but in the first call the average will only be made if the mark for each of the two partials is higher than 4.5. Otherwise, it will be necessary to make up the suspended part(s) in the second call

The final mark is obtained from the weighted average of all the evaluations, but in the first call the average will only be made if the mark of each of the two partials (block 1 and block 2) is higher than 4.5. Otherwise, it will be necessary to recover the part(s) suspended in the second call (recovery).

In the first call, if the student has not passed a partial with a grade >4.5, but the weighted average of all grades is equal to or greater than 5, the record will record a failing with a grade of 4.9.

In the second call, for the final grade the weighted average will be made only if the grade of each of the 2 partials (block 1 and block 2) is greater than 3.

In the second call, if the student has not passed a partial with a grade >3, but the weighted average of all grades is equal to or greater than 5, the record will record a failing with a grade of 4.9.

ALTERNATIVE ASSESSMENT: To facilitate work or family reconciliation there is the option of alternative assessment. It consists in:

- Single written test that represents 80% of the final grade for the subject (block 1 + block 2 + block 4). Students will do the exam the day of the second partial test.
- Attendance to laboratory practices is mandatory (mínimum of 80% of the hours)
- The presentation of the written and oral work of block 3 is mandatory (the day/time can be adapted to the possibilities of the students), which scores 20% of the total subject.

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. Devlin TM. 2015. Bioquímica. Libro de texto con aplicaciones clínicas. 4a edición. Ed. reverté. (7th edition available in english. Wiley-Liss Ed.)

4. Harper's. 2023. Harper's Ilustrated Biochemistry. Graw-Hill Education. 32 edició

5. Feduchi et al.2020. Bioquímica, conceptos esenciales. Ed, Médica Panamericana

6. Mathews CK, et al. 2013. Bioquímica. 4ª edición. McGraw-Hill Interamericana.

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