Universitat de Lleida

DEGREE CURRICULUM

# BIOCHEMISTRY

Coordination: ESPINET MESTRE, MARÍA CARMEN

Academic year 2021-22

# BIOCHEMISTRY 2021-22

## Subject's general information

<table>
<tr><td>Subject name</td><td>BIOCHEMISTRY</td></tr>
<tr><td>Code</td><td>101607</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 Biotechnology</td><td>1</td><td>COMMON</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>9</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRALAB</th><th colspan="2">PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>1</td><td>1.8</td><td>0.2</td><td>6</td></tr>
<tr><td>Number of groups</td><td>3</td><td>2</td><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>ESPINET MESTRE, MARÍA CARMEN</td></tr>
<tr><td>Department</td><td>BASIC MEDICAL SCIENCES</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
</table>

# BIOCHEMISTRY 2021-22

| Teaching staff | E-mail addresses | Credits taught by teacher | Office and hour of attention |
|---|---|---|---|
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| HERREROS DANES, JUDIT | judit.herreros@udl.cat | 2,8 | |
| ROS SALVADOR, JOAQUIN | joaquim.ros@udl.cat | 2 | |

## Learning objectives

Targets:

What are the chemical structures of the components of living matter.

How these components interact to give rise to organized supramolecular structures.

How living matter draws energy from the environment to maintain its existence.

How exactly an organism stores and transmits the information it needs to grow and reproduce exactly.

How chemical reactions are monitored inside living cells.

## Competences

Skills to which it contributes:

Basic skills

CB1 Students have to demonstrate to possess and understand knowledge in an area of study that starts from the basis of general secondary education, and is usually at a level that, although it is supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

CB2 The students have to know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies and the skills that are usually demonstrated through the development and defense of arguments and problem solving within their field of study.

CB3 That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

CB4 The students have to be able to transmit information, ideas, problems and solutions to both specialized and non-specialized audiences.

CB5 The students have to developed those learning skills necessary to undertake further studies with a high

degree of proficiency undertaking further studies with a high degree of autonomy.

General skills

GC1 Being able to selectively search for and use sources of information necessary to achieve the training objectives.

GC2 Interpret scientific-technical information with a critical sense, and be able to make presentations based on this information.

GC3 Working in a team, with a multidisciplinary vision and with the ability to make a rational and efficient distribution of tasks among team members.

GC4 Knowing and adequately using the scientific and technical vocabulary of the different areas of Biotechnology.

GC5 Working in the laboratory applying criteria of quality and good practice.

GC6 Knowing and knowing how to use the specific software and databases in the different fields of biotechnology.

GC7 Using the scientific method to analyze data and design experimental strategies with biotechnological applications.

GC8 Being able to form a critical judgment on the ethical, legal and environmental implications of biotechnology.

GC9 Being able to carry out a professional activity in accordance with safety regulations and respect for the environment and with ethical criteria.

GC10 Transmitting strategies and technological applications to the company, based on the general foundations of business economics.

GC11 Acquiring criteria for choosing the most appropriate analytical techniques for each specific practical case.

GC12 Developing work skills and interpersonal relations in a work environment and knowing the organization and structure of a company or institution.

Transversal skills

CT1 Being able to produce comprehensible written and oral reports on the work carried out, with a justification based on the theoretical-practical knowledge obtained.

CT2 To be able to communicate and communicate in the international sphere in their professional development.

CT3 To use information and communication tools and techniques for data analysis and the preparation of oral and written reports and other training and professional activities.

CT4 Respecting the fundamental rights of equality between men and women, the promotion of Human Rights and the values of a culture of peace and democratic values.

CT5 Applying the gender perspective to the functions of the professional field.

Specific skills

CE1 To know and understand the fundamentals of general, analytical and organic chemistry.

CE2 To know and understand the chemical fundamentals of biotechnological processes.

CE3 To know how to handle the essential instruments of a chemical laboratory.

CE4 To know the principles of physical chemistry and being able to solve problems related to the kinetics of chemical reactions.

CE5 To know the basic principles of chemical engineering.

CE6 To know how to relate the structure and reactivity with the functional properties of biomolecules.

SC7 To know the procedures for acquiring and preparing samples for instrumental chemical analysis.

CE8 To know the fundamentals, how to apply and interpret the instrumental techniques of biotechnological application.

CE9 Achieve a satisfactory command of concepts and procedures related to integral differential calculus and linear algebra.

CE10 Be able to apply mathematical procedures to scientific-technical situations necessary throughout the studies and in the future exercise of the profession.

CE11 To know how to use the basic concepts of the statistical method, being able to statistically analyze the results of studies and interpret them critically.

CE12 Understand the most important physical concepts and functions of mechanics, fluids, electricity and waves, in order to know how to apply them to solve problems in the professional field.

CE13 To know and understand the physical-mathematical foundations of biotechnological processes.

CE14 To know the biology of living beings at molecular, cellular, organic and population levels, with emphasis on organisms of biotechnological interest.

CE15 To know the biomolecules essential for life and the basic concepts of enzymology.

CE16 Be able to use basic analytical techniques for the determination of biochemical parameters.

CE17 To know the essential metabolic processes of living beings and their regulation.

CE18 Acquire an integrated vision of cellular structures, relating them to their specific functions and the biochemical processes involved.

CE19 To know the singularities of genetic analysis and its biotechnological functions.

CE20 Understand the function of genes and their regulation in response to external changes in the cell.

CE21 To know the fundamentals and methodology used in the genetic modification of organisms and knowing how to apply it.

CE22 Acquire a precise knowledge of the basic principles and physiological mechanisms of animal and plant organisms.

CE23 To know the fundamental aspects of the structure, metabolism, genetics and ecology of microorganisms, relating them to their possible technological use.

CE24 To know the principles of the immune response at molecular, cellular and physiological level, and the use of antigen-antibody reactions at analytical and diagnostic level.

CE45 To know the diversity of living beings, the importance of their maintenance and the management strategies from the biotechnological field.

CE25 To know the practice of microbial, animal and plant cell culture.

CE26 Be able to use experimental techniques for molecular, cellular and physiological analysis.

CE27 To know how to apply techniques for the analysis of molecular structures and for the detection and quantification of metabolites and macromolecules.

CE28 To know how to apply the techniques of omic analysis and interpretation of the results.

CE29 To know the design of bioreactors for the development of specific production processes.

CE30 To know the technological processes based on the use of living beings and their optimization strategies.

CE31 Be able to calculate, interpret and rationalize bioindustrial processes based on the relevant parameters in transport phenomena and thermodynamic balances.

CE32 To know the use of animal, plant and microbial cells in biotechnological processes.

CE34 Be able to design the protocol of a specific biotechnological process with the necessary practical requirements to carry it out and its evaluation parameters.

CE35 To know how a biotechnology laboratory works and be able to work in it.

CE44 To know the main fields of application of biotechnology and acquire basic training in some of them.

CE36 Have an integrated vision of the development process of a biotechnological product or application, incorporating the socio-economic and market aspects of the process.

CE37 To know how to use production management, quality management and project management in a biotechnology company.

CE38 To know the legislation related to the obtaining and dissemination of new products, as well as the evaluation of biotechnological risks.

CE39 To know how to search and obtain information from patent databases and the process of applying for a new patent.

CE40 Be able to critically judge public information on biotechnological innovations and the associated risks and to debate on these issues with scientifically based criteria.

CE41 To know how to design a prospective market research for a specific biotechnological product.

CE42 To know the mechanisms and particularities of the creation of biocompanies.

CE43 Be able to critically interpret the different ethical positions related to the application of biotechnology.

## Subject contents

ITEM 1. **Levels of molecular organization in living things**. Differential chemical properties of living matter. Bioelements. Biomolecules Origin, specialization and differentiation of biomolecules.

ITEM 2. **Biological importance of water**. Interaction of water with other biological components. Biological importance of water. Distribution of water in different organisms. Buffer systems in biological environments. Osmosis in living beings.

ITEM 3. **Carbohydrates**. Generalities Classification Monosaccharides: aldoses and ketoses. Disaccharides: the glycosidic link. Polysaccharides: structural, reservoir and gelling agents. Glycosaminoglycans and proteoglycans. Glycoproteins

ITEM 4. **Lipids.** General characteristics. Fatty acids and Acylglycerides. Glycerophospholipids, Sphingolipids, Isoprenoid lipids, Pyrroleic lipids. Prostaglandins. Leucotriens. Tromboxans.

ITEM 5. **Proteins**. Amino acids protein components. Structure and properties of amino acids. Rare and non-protein amino acids. Amino acid reactions. Peptide link Peptides Physical-chemical properties of peptides. Proteins Structural characterization and physical-chemical properties of proteins. Biological functions of proteins. Denaturalization Sequencing of proteins. Synthesis of peptides and proteins.

ITEM 6. **Biocatalysis**. Molecular structure of enzymes. Mechanism of enzymatic reactions. General

characteristics, active center, catalytic center and center of union. specificity of enzymes main classes of enzymes Structural characteristics. Isoenzymes Effect of enzymes on the speed and on the equilibrium constant of the catalyzed reaction. Activation energy concept.

ITEM 7. **Kinetics and regulation of enzymatic activity**. Control of enzymatic activity. Influence on the speed of the enzymatic reactions of pH, ionic strength and temperature. Enzymatic reactions with a single substrate and with several substrates. Kinetic Constants: Vmax, Kcat, Km. and S0.5. Alosterism. Mechanism for the activation of proenzymes (zymogens). Vitamins such as cofactors, precursors of cofactors, or prosthetic groups of particular enzymes. Describe and explain the structure, function, activation process, places and mode of action of the vitamins.

ITEM 8. **Introduction to metabolism**. Concept of metabolism and metabolic pathway. Phases of metabolism. Oxidoreductions in biochemical processes. Control and compartmentalisation of metabolic pathways.

ITEM 9. **Central routes of oxidative metabolism**. Production of acetyl-CoA. The piruvate dehydrogenase complex. Cycle of citric acid. Energy performance and regulation. Anaplerotic reactions. Cycle of glioxylate.

ITEM 10. **Electronic transport and oxidative phosphorylation.** Mitochondrial electronic transport chain. Origin and use of reduced substrates. Chemosmotic coupling: ATP synthase and oxidative phosphorylation. Mitochondrial transport systems. Regulation of oxidative phosphorylation. Energy balance of oxidative metabolism.

ITEM 11. **Metabolism of glucose.** Degradation of glucose: glycolysis and  of phosphate pentoses pathway. Fermentation. Gluconeogenesis. Synthesis and degradation of glycogen. Use of other glucides. Coordination in the control of the metabolism of glucose and glycogen: importance of the metabolic specialization of the tissues.

ITEM 12. **Photosynthesis**. Basic processes of photosynthesis. Photosynthetic pigments. Absorption of the energy of light. Electronic transport and photophosphorylation. Assimilation of CO2 and photosynthesis in the biosynthesis of glucides: Calvin's cycle. Regulation of photosynthesis. Photorespiration and C4 cycle.

ITEM 13. **Metabolism of lipids.** Lipoproteins: structure and function. Use of triacylglycerol in animals. Oxidation of fatty acids: metabolic route and regulation. Ketogenesis. Biosynthesis of fatty acids: metabolic route and regulation. Biosynthesis of triacylglycerols and phospholipids. Cholesterol metabolism. Synthesis and metabolism of bile salts.

ITEM 14. **Metabolism of nitrogen compounds.** Cycle of nitrogen. Intracellular protein degradation. Basic mechanisms of degradation of amino acids. The transaminases and metabolism of the amino group. Cycle of urea. Destiny of the carbonate skeleton. Biosynthesis of amino acids. Metabolism of the heme group. Proteins containing iron.

ITEM 15. **Nucleotide metabolism**. Degradation of nucleic acids and nucleotides. Recovery of nucleotides and synthesis again. Biomedical applications of nucleotide analogues.

ITEM 16. **Metabolic integration**. Metabolic profile of the most important organs. Mechanisms of metabolic regulation: global vision. Tissue interrelations. Metabolic adaptation to fasting / refeeding. Other examples.

ITEM 17. **Metabolism of xenobiotics**. Overview of biotransformations. Phase I and Phase II reactions. Citocrom P450: nomenclature, global reaction and biological functions. Inhibitors Electronic transport systems of the P450 cytochrome. Other oxygenation reactions.

**Practical activities**

LABORATORY PRACTICES

PRACTICE 1. Colorimetric determination of the concentration of proteins. Use of standard for qualification. We use control samples. Quantitative determination of the concentration of plasma proteins: Biuret method.

PRACTICE 2. Enzymatic kinetics. Essay of alpha amylase enzymatic activity. Determination of kinetic constants.

PRACTICE 3. Analysis of metabolic patametres.

PROBLEMS

The classes of problems will be carried out in parallel with regard to the agenda.

SEMINARS

This is a proposal that can vary depending on the actuality or impact of a particular topic.

## Methodology

The following activities will be programmed to achieve objective goals and acquire the attributed competences:

Part of the course is developed in one-hour theoretical concepts presentation sessions. These concepts are reinforced by one-hour seminar sessions and problems. Laboratory practices allow for a better understanding of theoretical concepts and the acquisition of basic skills in laboratory work. The bibliographic works will be done in groups of 20 students, on topics proposed and related to the subject. The presentation will be oral.

Master classes. (CM) Seminars. (Sem) Virtual activities (Av) Tutorials. (Tut) Computer classroom activities. (To Inf.) Laboratory practices. (PL).

## Development plan

COVID19 Plan

- Theoretical classes: Presentials

- Seminars: Presentials

-Computer seminars: Presentials

-Practices: Presentials

- Exams: All face-to-face.

## Evaluation

| Activity | qualification (%) |
|---|---|
| **Theory exams 1, 2, 3** | 25, 22, 25 |
| **Problems** | 12 |
| | 16 |
| **Total** | 100 |

With a mark of 4 or more in exams 1 and 2 and 3, you get average with work and tests on seminars and practices. If the result is 5 or more, the corresponding subject part is approved and not required recover. If the exam is less than 4 or the average is less than 5, the subject must be recovered.

## Bibliography

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11. Strayer L, Berg J, Tymoczko J. 2014. Bioquímica. 7ª ed. Ed. Reverté ( 6ª edició en català).

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