Teaching guide

IDENTIFICATION DETAILS

Degree:	Biomedicine
Scope	Biology and Genetics
Faculty/School:	Experimental Sciences
Course:	BIOCHEMISTRY
Type:	Basic Training
ECTS credits:	8
Year:	1
Code:	2140
Teaching period:	First-second semester
Subject:	Biochemistry
Module:	Biochemistry and Molecular Biology
Teaching type:	Classroom-based
Language:	Spanish
Total number of student study hours:	200

SUBJECT DESCRIPTION

Biomedicine is based on knowledge of areas such as Molecular Biology, Biochemistry, Molecular Genetics, etc., to help understand how pathological processes are triggered and developed in living beings (in a very special way, in human beings). This in-depth knowledge of the disease from its molecular basis to the pathophysiological level is necessary in order to improve the tools for diagnosing and treating diseases.

Biochemistry is the science that is responsible for studying the chemical constituents of living beings, their functions and the transformations they undergo within an organism in order to obtain new structures and energy necessary for the development of life. Thus, Biochemistry consists of the study of life from a molecular point of view.

The subject of Biochemistry taught in the first year of the degree in Biomedicine includes the study of: 1) the molecular units of life (carbohydrates, lipids, amino acids and nitrogenous bases, which are, in turn, the constituents of macromolecules); 2) the relationship between their structure and function; and 3) the set of chemical reactions, which combined in the different metabolic routes, take place inside single- or multi-cellular organisms and which constitute the basis of life at the molecular level and allow all cells carry out vital processes such as nutrition or growth.
In order to ensure that the student acquires the above-mentioned knowledge, the subject has been essentially organized into theoretical classes and practical classes. With regard to theoretical classes (which will occupy most of the credits of the subject), the program has been divided into two different sections. In the first one, an introduction to structural biochemistry will be carried out and the main types of biomolecules will be analyzed, paying particular attention to the relationship between composition, structure and function. In the second, metabolic biochemistry will be studied, with special emphasis on cellular metabolism and its main characteristics (division between anabolism and catabolism, energy processes, energy-activated metabolites, regulatory mechanisms...), on the metabolic pathways in which biomolecules participate and the interregulation of the various metabolic routes that occur between the various organs of higher organisms (such as the human being) in addition to the study of different physiological situations such as starvation or diabetes mellitus.

GOAL

The objective of the course is for the student to acquire the elementary knowledge related to the discipline of Biochemistry (both at the level of Structural Biochemistry and Metabolic Biochemistry) and which are necessary to contribute to the more general knowledge of how an organism is organized and behaved at a biological level.

The specific aims of the subject are:

Know the main types of biomolecules present in living beings.

Understand the basic principles that govern the relationship between composition, structure and function of biomolecules.

Understand the basis of metabolic processes, the different levels of organization of routes, coupling of energy processes and different regulatory mechanisms of the enzymes that participate in these routes.

Learn about the different metabolic pathways in which the main biomolecules participate.

Being able to interrelate a metabolic route in one organ with other routes in other organs.

Learn the basic clinical implications of potential alterations in the metabolism of biomolecules.

To know from an experimental point of view certain properties of biomolecules as well as their participation in metabolic processes.

PRIOR KNOWLEDGE

The student who studies the subject of Biochemistry and wishes to obtain optimal use of it, must start at least a level of knowledge of 2nd year of Baccalaureate for the subjects of Chemistry and Biology.

COURSE SYLLABUS

FIRST PART OF THE SUBJECT: STRUCTURE OF LIVING MATTER.
TOPIC 1. INTRODUCTION TO BIOCHEMISTRY. Characteristics of living beings. Chemical composition. Biomolecules: properties. Principles of Biochemistry.
TOPIC 2. MOLECULAR FORCES AND THREE-DIMENSIONAL STRUCTURE AND AQUEOUS EQUILIBRIA. Types of non-covalent interactions and their relationship with the three-dimensional structure of biomolecules. Water as a universal solvent. Structure and properties of water. Weak interactions in aqueous systems.
TOPIC 3. CARBOHYDRATES. Monosaccharides: nomenclature. Review of the key concepts of stereoisomerism. Pentoses and hexoses. Disaccharides. Glucidic bond. Reserve polysaccharides: glycogen and starch. Structural polysaccharides: proteoglycans. Glycoproteins and glycolipids. Brief introduction to biological functions.
TOPIC 4. LIPIDS. Storage lipids: fatty acids, triacylglycerols. Structural lipids: glycerophospholipids, sphingolipids, sterols. Lipids with specific biological activities: icosanoids, fat-soluble vitamins. Brief introduction to biological functions.
TOPIC 5. AMINO ACIDS. Structure and properties of amino acids. Classifications of amino acids according to their side chains. Stereoisomerism of amino acids. Non-standard amino acids. Post-translational amino acid modifications. Acid-base properties and titration curves.
TOPIC 6. PROTEINS. Biological functions and primary structure. Peptide bond. Peptides and proteins. Diversity of biological functions. Levels of structural organization of proteins. Primary structure. Information from the amino acid sequence. Homologous proteins.
TOPIC 7. SECONDARY, TERTIARY AND QUATERNARY STRUCTURE OF PROTEINS. Weak forces that stabilize the three-dimensional structure. Peptide bond geometry. Secondary structure: alpha helices, beta blades and beta turns. Fibrous proteins: alpha-keratin, collagen. Globular proteins. Supersecondary structures. Tertiary structure. Quaternary structure. Hemoglobin: structure and function.
TOPICS 8. ENZYMES. Classification. Principles of enzyme catalysis. Activation energy. Reaction speed and reaction equilibrium. Covalent acid-base catalysis by metal ions. Introduction to enzyme kinetics: Michaelis-Menten equation. Enzyme inhibition.
TOPIC 9. NUCLEOTIDES AND NUCLEIC ACIDS. Nucleotide structure and nomenclature. Properties of nitrogenous bases. Structure of nucleic acids. The double propeller. Types of secondary/tertiary structures in DNA and RNAs. Nucleic acid chemistry.
2ND PART OF THE SUBJECT: METABOLISM OF LIVING BEINGS.
TOPIC 10. INTRODUCTION TO CELLULAR METABOLISM. Cellular Metabolism Concept. Catabolism and Anabolism. Levels of metabolic organization. Thermodynamic fundamentals. Coupled systems. ATP and other activated metabolites.
TOPIC 11. CARBOHYDRATE METABOLISM I: ANAEROBIC CATABOLISM. Glycolysis. Anaerobic destinations of pyruvate: Fermentations. Stoichiometry and energy balance. Incorporation of other sugars into the glycolytic route. Reserves and distribution of glycogen in the body. Mobilization and degradation of glycogen.
TOPIC 12. CARBOHYDRATE METABOLISM II: AEROBIC CATABOLISM AND OXIDATION PROCESSES. Pyruvate oxidation. Citric acid cycle. Stoichiometry and energy balance. Anaplerotic reactions.
TOPIC 13. ELECTRONIC TRANSPORT AND OXIDATIVE PHOSPHORYLATION. The mitochondria. Redox reactions. Electronic transport through the respiratory chain. Oxidative phosphorylation and ATP synthetase.

Control of respiratory conditions. Transport systems through the mitochondria. Energy performance of oxidative metabolism.
TOPIC 14. CARBOHYDRATE METABOLISM III: THE PENTOSE PHOSPHATE PATHWAYS. Pentose phosphate route. Oxidative and non-oxidative phases. The NADPH.
TOPIC 15. CARBOHYDRATE METABOLISM IV: ANABOLISM. Gluconeogenesis. Stoichiometry and energy balance. Cori cycle. Glycogen synthesis.
TOPIC 16. LIPID METABOLISM I: CATABOLISM OF FATTY ACIDS AND TRIACYLGLYCEROLS. Digestion and absorption of fats or triacylglycerols. Lipoproteins and their metabolism. Mobilization of fats and cholesterol in the body. Transport of fatty acids to mitochondria. Beta-oxidation of fatty acids. Stoichiometry and energy balance of beta-oxidation. Generation and importance of ketone bodies.
TOPIC 17: LIPID METABOLISM II: ANABOLISM OF FATTY ACIDS AND TRIACYLGLYCEROLS. Fatty acid biosynthesis. The acyl carrier protein (ACP). Fatty acid biosynthesis reactions. Biosynthesis of fats or triacylglycerols.
TOPIC 18. AMINO ACID METABOLISM. Amino acid degradation. Deamination of amino acids. The urea cycle. Degradation of individual amino acids. Amino acids as biosynthetic precursors. Biosynthesis of amino acids. Nitrogen fixation.
TOPIC 19. NUCLEOTIDE METABOLISM. General strategy in the biosynthesis of nucleotides: de novo routes and rescue routes. PRPP and its importance in nucleotide biosynthesis pathways. Biosynthesis and degradation of purine ribonucleotides. Biosynthesis and degradation of pyrimidine ribonucleotides. Biosynthesis and degradation of deoxyribonucleotides.
TOPIC 20. METABOLIC REGULATION MECHANISMS. Basic mechanisms of regulation of metabolism. Allosteric regulation. Transcription control. Hormonal control.
TOPIC 21. REGULATION OF MAJOR METABOLIC PATHWAYS. Regulation of glycolysis and gluconeogenesis. Regulation of glycogen degradation and synthesis. Regulation of the activity of the pyruvate dehydrogenase complex and the Krebs cycle. Regulation of the mobilization of triacylglycerol stores and of the degradation and synthesis of fatty acids.
TOPIC 22. METABOLIC AND METABOLIC INTEGRATION OF THE MOST IMPORTANT ORGANS. Interdependence between the main organs involved in metabolism. Hormonal regulation of metabolism in different organs. Adaptation to different metabolic situations.

EDUCATION ACTIVITIES

The classes of the Biochemistry course will make use of the following methodologies in order to achieve the proposed objectives: 1) Expository classes taught by the teachers in which the theoretical bases of the subject will be established. 2) Face-to-face seminars in which, on the one hand, issues will be worked on to strengthen the contents developed during the expository classes and, on the other, to reinforce content previously and autonomously worked by the students, thus using an inverted methodology. 3) Practical sessions (located in experimental teaching laboratories or other spaces) so that students can come into contact with the experimental reality of Biochemistry. 4) Individual and group tutoring, at the request of the students or at a time previously established by the teacher, where all questions raised by the study of the subject will be developed and answered. The teachers of the subject do not authorize the publication by the student of the material provided by the teachers of the subject in the virtual classroom, or by any other means.

DISTRIBUTION OF WORK TIME

TEACHER-LED TRAINING ACTIVITIES	INDIVIDUAL WORK
80 Horas	120 Horas

LEARNING RESULTS

Know the main metabolic reactions (catabolic and anabolic) that take place in living organisms and the bioenergetics of the associated processes.

Learn to identify the composition of the different main biomolecules (sugars, lipids, amino acids and proteins) that are part of living organisms, their structure and the relationship between them and their functions.

SPECIFIC LEARNING RESULTS

Identify the structures (in their various forms of projection when necessary) of different biomolecules of biochemical interest.

Recognize the role played by the various biomolecules of biochemical interest and the relationship that exists between their structure and the function performed (with special attention to the levels of primary, secondary, tertiary and quaternary structure of proteins) .

Know the nature of the various types of bonds that allow monomeric biomolecules to be joined to generate macromolecules of biochemical interest.

Describe the principles of enzyme catalysis and how enzymes carry out their functions.

Relate the enzymes to the corresponding substrates and products (including their structures) for each of the metabolic pathways studied throughout the program.

Identify the regulatory factors to which the enzymes that control each of the metabolic pathways being studied are subject.

Calculate the energy performance of each of the metabolic pathways being studied.

Know the interrelation between the metabolic pathways studied and the different organs of higher organisms where they take place

LEARNING APPRAISAL SYSTEM

The following percentages will apply to both ordinary and extraordinary calls:
- Evaluation of the theoretical content of the subject through oral or written tests with development, short answer or

test-type questions: 60%. You will evaluate learning outcomes RA1, 2, 3, 4, 5, 6, 7 and 8.
- Carrying out and evaluating the practical work carried out in the laboratory: 20%. You will evaluate learning outcomes 1, 2 and 7.
- Evaluation of work in seminars: 20%. You will evaluate learning outcomes RA2, 4 and 5. Passing the subject will require obtaining a minimum grade of 5 in each of the sections (both in the ordinary and in the extraordinary call).
Ordinary call:
1) Evaluation of the expository classes: With regard to the evaluation of the expository classes, two partial exams will be carried out. The first one will take place once the first semester has ended (although it will only include the contents of the part of the subject corresponding to structural biochemistry). The second one must be completed at the end of the second semester (and, in addition, it will include the metabolic biochemistry content taught in the first semester). These two partial periods will have a liberatory effect on the corresponding subject for the final exam on the condition of obtaining a grade of 5 or higher (only one semester is released if 5 is obtained in the corresponding partial). If only one of the two semesters is released, the final exam of the ordinary call must be taken with the semester not passed. If you do not release either semester, you will attend the end of the call with the entire course. The first partial exam will constitute 40% of the score in this section and the second partial exam will constitute 60% of it. If they do not pass this part of the subject in the ordinary call, the student must be examined for all the expository classes in the extraordinary call. The partial overcoming of the theoretical content does not prevent the student from giving up their two partial grades to take the final exam of the ordinary call with all the content and to be able to score. You cannot give up just one of the two partials. There will be no more deadline for giving up the score obtained in partial form than the day on which the final exam takes place. In any case, the exams that evaluate the expository classes may contain test-type, short or developmental questions.
2) Evaluation of practical classes: The evaluation section of practical work will include the preparation of an internship report for each of the laboratory sessions plus the completion of a written exam on the same date as the call for the final exam of the expository classes (or on another available date). This written exam of the practical work in the laboratory will consist of short questions where the student demonstrates that they have understood the objectives and development of each of the practices. The grade of the practical work will result from calculating the weighted average between the reports and the written exam applying the following percentages: 50% written exam and 50% the three practice reports (the arithmetic average of the three reports will be calculated). It will be essential to obtain a minimum score of 4.5 in the written exam or in the reports so that you can compute for the grade of this part of the subject. The trainee teacher will indicate when the corresponding reports are due to be delivered. Failure to submit each of the reports within the corresponding deadline will result in an automatic score of zero. With regard to laboratory practices, your attendance is mandatory. Only in cases of extreme seriousness (to be determined by the teacher together with the management of the Degree) will non-attendance be allowed on the date on which the student is officially invited and the transfer to another group on other dates. If they do not attend any of the sessions, the student must justify it properly, recover that practice (if there are still dates available) and do a written work (to be specified by the teacher of the subject). Failure to attend more than one of the practical sessions will mean not exceeding this section of the subject and in the extraordinary call the student, in addition to being examined in writing, must pass a practical exam. The time allocated for learning and carrying out the internships is that stipulated in the official calendar of the subject. The recovery of internships at a different time is not contemplated.
3) Evaluation of seminar papers, exercises: In relation to the evaluation of the work carried out in the seminars, the student will be required by the teachers to submit a series of materials (exercises, resolution of practical cases, etc...) within specific dates. This percentage of the final grade will result from the arithmetic average obtained from the grades of each of the deliveries made.
The grade of each section of the subject will be influenced by the spelling with which the student has answered the questions. In this way, the spelling correction criteria for the Evaluation for University Access (EVAU) exams applied in recent years will be applied. According to these criteria: 1) Each error in the spelling will subtract 0.25 points from the final grade of the exercise and the errors in the accents 0.15 points, up to a maximum of 4 points in both cases. 2) The same repeated fault will be taken into account only once. 3) The repetition of misspellings may even lead to the qualification of suspense. 4) Abbreviations, syntactic errors, grammatical errors will be

penalized...
It will be an essential requirement to pass the subject: 1) pass the written exam of the expository classes, 2) attend each and every laboratory practice (as mentioned in the previous paragraphs, 3) pass the written exam of the practical laboratory work and 4) the delivery and presentation on due date of the practice reports and all material generated in the seminars developed throughout the course. If these requirements are not met, the student will not pass the call.
Extraordinary call: If in the ordinary call the student has met some of the four requirements listed in the previous paragraph but not all, the qualifications of those parts that he would have passed will be maintained for the extraordinary call. Thus, in this call, you will only have to overcome the pending parts. The student who has to be examined in the expository classes, as described above, will do so for the entire subject (partial grades are not saved for the extraordinary call). The nature of the exams to evaluate the practical classes and the practical work carried out in the laboratory will be similar to that of the ordinary call. If the student has not made any of the submissions required by the teachers, a new delivery will be ordered to be made before the deadline for the extraordinary call.
IMPORTANT NOTES:
1) STUDENTS IN SECOND OR SUBSEQUENT ENROLLMENT MAY TAKE ADVANTAGE OF AN ALTERNATIVE EVALUATION SYSTEM IN WHICH THE EXPOSITORY CLASSES WILL BE EQUIVALENT TO 70% OF THE FINAL GRADE (WITH THE DISTRIBUTION INDICATED ABOVE BY PARTIAL ONES); THE EVALUATION OF PRACTICAL CLASSES WILL BE EQUIVALENT TO 20%; AND, FINALLY, THE STUDENTS WILL CARRY OUT SPECIFIC ACTIVITIES AND EXERCISES THAT THE TEACHERS WILL INDICATE AND DELIVER ON THE DATES REQUIRED TO COVER THE LAST 10% OF THE GRADE OF THE SUBJECT. THOSE STUDENTS IN SECOND OR SUBSEQUENT ENROLLMENT SHOULD CONTACT THE TEACHER TO REQUEST TO TAKE ADVANTAGE OF THIS SYSTEM.
2) PLAGIARISM, AS WELL AS THE USE OF ILLEGITIMATE MEANS IN EVALUATION TESTS, WILL BE SANCTIONED IN ACCORDANCE WITH THE UNIVERSITY'S EVALUATION REGULATIONS AND REGULATIONS ON COEXISTENCE.

ETHICAL AND RESPONSIBLE USE OF ARTIFICIAL INTELLIGENCE

1.- The use of any Artificial Intelligence (AI) system or service shall be determined by the lecturer, and may only be used in the manner and under the conditions indicated by them. In all cases, its use must comply with the following principles:
a) The use of AI systems or services must be accompanied by critical reflection on the part of the student regarding their impact and/or limitations in the development of the assigned task or project.
b) The selection of AI systems or services must be justified, explaining their advantages over other tools or methods of obtaining information. The chosen model and the version of AI used must be described in as much detail as possible.
c) The student must appropriately cite the use of AI systems or services, specifying the parts of the work where they were used and describing the creative process followed. The use of citation formats and usage examples may be consulted on the Library website(https://www.ufv.es/gestion-de-la-informacion_biblioteca/).
d) The results obtained through AI systems or services must always be verified. As the author, the student is responsible for their work and for the legitimacy of the sources used.
2.- In all cases, the use of AI systems or services must always respect the principles of responsible and ethical use upheld by the university, as outlined in the Guide for the Responsible Use of Artificial Intelligence in Studies at UFV. Additionally, the lecturer may request other types of individual commitments from the student when deemed necessary.
3.- Without prejudice to the above, in cases of doubt regarding the ethical and responsible use of any AI system or service, the lecturer may require an oral presentation of any assignment or partial submission. This oral evaluation shall take precedence over any other form of assessment outlined in the Teaching Guide. In this oral defense, the

student must demonstrate knowledge of the subject, justify their decisions, and explain the development of their work.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

Mathews, Christopher K. (1937-) Biochemistry/4th ed. Madrid: Pearson Higher Education, 2013.

VOET, Donald. Foundations of Biochemistry: Life at the Molecular Level/4th ed. Buenos Aires; Madrid:Editorial Médica Panamericana, 2016.

VOET, Donald. Biochemistry/4th ed. [s.l.] :John Wiley & Sons, 2011.