COURSE DESCRIPTION

COURSE DETAILS

Title (of the course): **BIOQUÍMICA**
Code: 100407
Degree/Master: **GRADO DE BIOLOGÍA** Year: 2
Name of the module to which it belongs: BIOQUÍMICA
Field: BIOQUÍMICA
Character: OBLIGATORIA Duration: ANUAL
ECTS Credits: 12.0 Classroom hours: 120
Face-to-face classroom percentage: 40.0% Study hours: 180
Online platform: Moodle

LECTURER INFORMATION

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PREREQUISITES AND RECOMMENDATIONS

Prerequisites established in the study plan

The knowledge of English language (B1 level) is compulsory.

Recommendations

The knowledge of English language (B2 or higher level) is highly recommended.

COURSE DESCRIPTION

INTENDED LEARNING OUTCOMES

CU2

CB17v1

CE20v4

CE21v8

CE25v1

CE26v1

OBJECTIVES

The main goal of this subject is to establish the basic knowledge of biochemistry and molecular biology necessary to understand the structure and function of biomolecules, the regulation of biological processes and the molecular basis that underlies the similarities and differences between different living beings, which will allow by understanding the molecular functioning of different organisms, their responses to environmental stimuli and the mechanisms of adaptation to the environment, as well as the importance of said knowledge for the identification and resolution of multiple problems through biotechnological applications.

In particular, the learning objectives are:

1.- The student will acquire basic knowledge of biochemistry and molecular biology to understand the complexity and functioning of biological processes at the molecular level, underlining both the molecular logic common to all living beings and the differential aspects that entails biodiversity.

2.- The student will develop the ability to solve numerical problems and calculations of basic data in quantitative biochemistry.

3.- The student will know the basic biochemical techniques and their main applications.

4.- The student will understand the impact of biochemistry and molecular biology on society today, and in particular clinical, agri-food and environmental biotechnology applications.

In addition to basic knowledge of biochemistry and molecular biology, the student must acquire certain skills and abilities, such as the ability to deal with bibliographic works with a certain level of depth, the ability to compare and relate concepts and apply them to specific problems, interest in new technologies applied to biology, and the development of critical attitudes based on scientific knowledge.

CONTENT

1. Theory contents

THEORY CONTENT

60 hours per year/ (30 hours each term)

FIRST TERM

Lecture 1. INTRODUCTION TO BIOCHEMISTRY. THE MATRIX OF LIFE (#)

Objectives of Biochemistry. Biochemistry as an interdisciplinary Science. Biochemistry applications and future perspectives. The importance of water in biological systems. Structure, physical and Chemical properties of water. Weak interactions in aqueous systems. Buffers. Non-covalent interactions. Interactions between macromolecules in solution.

Lecture 2. AMINO ACIDS AND PROTEIN STRUCTURE (#)

Types of amino acids. Peptide bond: structure and properties. Natural peptides. Fibrous and globular proteins. Structural levels of proteins and main interactions. Alpha helix, beta sheets, turns, loops and other structures. Protein tertiary structure: motifs, domains and folds. Monomeric and oligomeric proteins. Quaternary structure

Lecture 3. PROTEINS. STRUCTURE AND FUNCTION RELATIONSHIP.

Protein folding. Chaperones and others auxiliary folding elements. Structure-function relationship. Myoglobin and

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hemoglobin. Cooperativity in oxygen binding and modulation by effectors. Abnormal proteins: molecular pathologies of hemoglobin. Evolution of proteins

Lecture 4. ENZYMES (#)

General characteristics of enzymes as biological catalysts. Nomenclature and classification. Active site concept. Enzyme-substrate interaction. Essential functional groups in catalysis. Factors that contribute to catalytic efficiency. Molecular mechanism of action of chymotrypsin. Effect of pH and temperature on enzymatic reactions. Types of enzymatic cofactors. Coenzymes and vitamins water soluble. Enzyme technology.

Lecture 5. KINETICS AND ENZYMATIC INHIBITION (*)

Generalities. Michaelis-Menten equation. Concept and meaning of kinetic parameters: catalytic constant, Vmax and KM. Catalytic efficiency. Practical determination of Vmax and KM. Inhibition of enzymatic reactions. Types of inhibition. Kinetic characteristics of the competitive, non-competitive and uncompetitive inhibition.

Lecture 6. Regulation of enzymatic activity

Control of enzymatic activity. Enzymes regulatory. Allosterism and cooperativity. Interconvertible enzymes: regulation by covalent modification reversible. Activation by proteolytic cutting: zymogens. Control of the amount of enzyme: synthesis and degradation.

Lecture 7. STRUCTURE AND FUNCTION OF CARBOHYDRATES

Classification and main functions of carbohydrates. Monosaccharides: chemical characteristics, isomerism and conformational analysis. Glycosidic bond. Main disaccharides: sucrose, lactose and maltose. Energy reserve polysaccharides: starch and glycogen. Polysaccharides structural: cellulose and chitin. Glycosaminoglycans. Glycoconjugates. Carbohydrates as molecules informative: carbohydrate-lectin interactions.

Lecture 8. STRUCTURE AND FUNCTION OF LIPIDS

Cell membranes. Contents: General characteristics and lipid classification. Simple lipids and complex lipids. Fatty acids. Acyl glycerides. Phospholipids. Sphingolipids. Eicosanoid lipids. Isoprenoid lipids and sterols Chemical organization and properties of biological membranes. Mechanisms of transport through membranes.

Lecture 9. Nucleotides and nucleic acids: structure and function.

Nucleotides and nucleotides. Structure of DNA: the double helix. DNA conformations: DNA A, B and Z. Physicochemical properties of DNA. DNA packaging. RNA structure. Structural and functional types. Small RNAs. Coding and flow of genetic information.

Lecture 10. MOLECULAR BIOLOGY I: DNA METABOLISM (*)

DNA as a carrier of information Genetics: Central Dogma of Molecular Biology. DNA Replication. DNA polymerases. Main proteins involved in replication and molecular events. Replication in eukaryotes. Mutations in DNA: types and causes. Mutagenic agents Mutation repair mechanisms.

Lecture 11. MOLECULAR BIOLOGY II: RNA METABOLISM

RNA synthesis: transcription. Differences in transcription between prokaryotes and eukaryotes. RNA polymerases and transcription factors. Processing and RNA maturation. Translation of messenger RNA: ribosomes and ribosomal RNA, transfer RNA and aminoacylt RNA synthetases. DNA-protein interactions and basic principles of the regulation of transcription and translation. Differences in regulation between prokaryotes and eukaryotes.

SECOND TERM

Lecture 12. BIOENERGETICS. INTRODUCTION TO METABOLISM AND METABOLIC REGULATION (#)

Laws of the thermodynamics. Enthalpy, entropy and free energy. Cellular energy. Coupling of reactions. ATP and transfer of phosphoryl groups. Measurements of the cellular energy environment. Overview of metabolism. Main metabolic routes. Need for metabolic control. Hormonal control in plants and animals. Signal transduction, second messengers and molecular mechanisms.

Lecture 13. KREBS CYCLE (#)

Central role of the Krebs cycle in intermediate metabolism. The pyruvate as a metabolic crossroads. Oxidation of pyruvate to acetyl-CoA. General characteristics of the cycle Krebs. Description of the route. Regulation. Amphibolic character of the cycle and anaplerotic reactions. Cycle of glyoxylate.

Lecture 14. OXIDATIVE PHOSPHORYLATION AND PHOTOPHOSPHORYLATION (#)

Organization and operation of the chain of electronic transport. Chemosmotic mechanism. Structure and mechanism of action of ATP synthase. Inhibitors and decouplers of the electron transport chain. Shuttle systems for the entry of cytoplasmic electrons in the mitochondria. Molecular mechanism of photosynthesis.

COURSE DESCRIPTION

Photosynthetic pigments and photosystems. Non-cyclic electronic transport: synthesis of NADPH. Cyclical flow of electrons. Photophosphorylation. Bacterial photosynthesis.
Lecture 15. Carbohydrate metabolism (#)
Glycolysis: phases, reactions and energy balance. Destinations fermentation of pyruvate. Entry of other sugars in the glycolytic pathway. Glucose synthesis: gluconeogenesis. Biosynthesis and glycogen degradation. Reciprocal regulation of glycolysis and gluconeogenesis and of synthesis and glycogen degradation Pathway of pentose phosphate: generation of reducing power in the form of NADPH and alternative destinations of the pentose phosphate. Photosynthetic fixation of carbon dioxide: Calvin-Benson cycle. CO2 fixation in C4 plants and CAM plants.
Lecture 16. LIPID METABOLISM (#)
Lipid absorption and transport. Fat mobilization. Activation and transport of fatty acids into the mitochondria. Oxidation of chain saturated fatty acids odd. Oxidation of unsaturated fatty acids. Ketone bodies. Fatty acid biosynthesis: transport of Mitochondrial acetyl-CoA alcitosol, acetyl-CoA carboxylase, fatty acid synthase. Elongases and desaturates. Regulation of fatty acid metabolism. Synthesis of triacylglycerols and glycerophospholipids. Lipid synthesis isoprenoids.
Lecture 17. Metabolism of nitrogenous compounds
Nitrogen cycle in the biosphere. Incorporation of ammonium nitrogen to carbon skeletons. Protein exchange. Transamination reactions, amino acid deamination and decarboxylation Amino acid degradation: glycogenic amino acids and ketogenic. Fate of ammonia: urea cycle and its regulation. Amino Acid Biosynthesis: Amino Acids essentials and biosynthetic families. Biosynthesis and degradation of purine nucleotides. Biosynthesis and degradation of pyrimidine nucleotides. Deoxyribonucleotide biosynthesis.
Lecture 18. Integration of metabolism
Metabolic profile of the main organs and tissues. View integrated metabolism of carbohydrates, lipids and amino acids. Metabolic interrelationships in different physiological and pathological situations. Metabolic stress response: fasting situations, intense exercise and diabetes. Coordination between organs and tissues Integration of the hormonal response.
Lectures supported by laboratory practices (*) and classroom practices (#)

2. Practical contents

PRACTICAL CONTENT
The practical contents include laboratory practices (*) and classroom practices (#) with problem solving and discussion on practical cases of metabolism.
Three laboratory practices will be carried out.
1- The polymerase chain reaction (PCR) (Lecture 10)
2- Separation of biomolecules by electrophoresis (Lecture 10).
3- spectrophotometric analysis and kinetic characterization of alkaline phosphatase enzyme activity (Lecture 5)
Classroom practices will consist of posing, solving and discussing problems and questions that are complementary to the theoretical content. This part of problem solving during the first term will deal with pH-metry and acid-base behavior of amino acids and proteins and enzyme. In the second term, the practical classroom contents will consist of the resolution of bioenergetics problems, as well as metabolic cases, with discussion of issues related to the different metabolic pathways and their alterations. Finally, the possibility of holding seminars and work is contemplated, as a face-to-face complementary activity, which will deal with aspects, applications, methodologies, etc., related to the contents of the theoretical or practical program, which have not been treated in detail in the classes.

SUSTAINABLE DEVELOPMENT GOALS RELATED TO THE CONTENT

Zero hunger
Good health and well-being
Quality education

COURSE DESCRIPTION

Gender equality
Clean water and sanitation
Affordable and clean energy
Decent work and economic growth
Industry, innovation and infrastructure
Sustainable cities and communities
Responsible consumption and production
Climate action
Life below water
Life on land

METHODOLOGY

General clarifications on the methodology (optional)

The theoretical classes are taught with powerpoint presentations (.ppt) that are "hung" in Moodle in pdf format. These represent only a script-summary for the development and subsequent study by the student of the topic. In relation to problem solving (case studies), a list of exercises is proposed, some of which are explained and developed in class. The rest is left for students to practice at home and ask questions in class

Methodological adaptations for part-time students and students with disabilities and special educational needs

The methodological adaptations for part-time students will be decided in meetings between the teaching staff and interested students in order to personalize the possible cases that arise. This will be valid both for the teaching methodology and for the evaluation. In principle, the same assessment instruments will be used as for students enrolled full-time

Face-to-face activities

Activity	Large group	Medium group	Small group	Total
Assessment activities	6	-	-	6
Case study	-	40	-	40
Lab practice	-	-	9	9
Lectures	60	-	-	60
Seminar	-	5	-	5
Total hours:	***66***	***45***	***9***	***120***

Off-site activities

Activity	Total
Activities	30
Analysis	5
Exercises	5

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Activity	Total
Information search	10
Reference search	10
Self-study	120
Total hours	***180***

WORK MATERIALS FOR STUDENTS

Case studies
Coursebook
Exercises and activities
Oral presentations
Placement booklet
References

Clarifications

The theoretical contents worked on in the GG will be presented through master classes using PowerPoint presentations (which is only a summary for later development by the student of the topic) that will be posted on the Moodle platform.
For the Problems classes (case studies) and Classroom Practices, presentations will be used and collections of problems and exercises will be provided, which will also be available on the Moodle platform.
We fully recommend the use and consultation of the subject's own bibliography.
For the Laboratory Practices, protocols will be provided to carry them out, and the students MUST make and deliver a Notebook of Practices with the results obtained and the discussion of the same

EVALUATION

Intended learning	Exams	Laboratory Practice	Problem solving
CB17v1	X	X	X
CE20v4	X	X	X
CE21v8	X	X	X
CE25v1	X	X	X
CE26v1	X	X	X
CU2	X	X	X
Total (100%)	***70%***	***10%***	***20%***
Minimum grade	***5***	***5***	***5***

(*)Minimum mark (out of 10) needed for the assessment tool to be weighted in the course final mark. In any case, final mark must be 5,0 or higher to pass the course.

COURSE DESCRIPTION

Attendance will be assessed?:

No

General clarifications on instruments for evaluation:

- Attendance at practices sessions is mandatory.
- Students must take and pass the two partial evaluations (one at the end of each term), or failing that, the final evaluation with all the unpassed subject, on the officially agreed dates by UCO.

- Evaluation will consist of Theory questions (short answers and/or development and/or test type) valued up to 7 points and Problem Solving up to 2 points, total 9 points. Participation in the laboratory practices and elaboration and discussion of reports is mandatory and will be valued up to 1 point in the final grade. Additionally, and **only when the subject is passed**, the completion of Seminars and other optional activities may entail up to 1 point in the final grade (0.5 points / subject of each term).

- To pass the course a student must achieve 50 points out of 100. Each partial must be approved with 50% of its value (the weighted sum theory and problems). Partials can only be compensated when at least one has 40% and the other is equal to or greater than 60%. Students who pass both partials will be graded with this weighted sum plus the calificationes of laboratory practices and seminars. Students who have not passed one or both partial evaluations will take a final assessment exam in June with the theory and/or the problems not yet that passed. In the July call, there will be a final evaluation of the theory and/or the problems that has not yet been eliminated.
- Repeating students may substitute the attendance and memory of laboratory practices for a written work related to any of the techniques used in the practices of this course.

Clarifications on the methodology for part-time students and students with disabilities and special educational needs:

The methodological adaptations for part-time students will be decided in meetings between the teaching staff and interested students in order to personalize the possible cases that arise. This will be valid both for the teaching methodology and for the evaluation. In principle, the same assessment instruments will be used as for students enrolled full-time

Clarifications on the evaluation of the first extraordinary call and extra-ordinary call for completion studies:

For these evalutions, the same assesment instruments and criteria especified in the Table will be used but the calificationes of laboratory practices and seminars from last year will be considered.

Qualifying criteria for obtaining honors:

Equal to or greater than 9,5 will be considered with an additional exam at the teacher´s discretion

BIBLIOGRAPHY

1. Basic Bibliography

1. Bibliografía básica

1. (***English***) Nelson DL y Cox MM. **LEHNINGER. Principles of Biochemistry_8th Ed**. MacMillan-Learning, (2021). Paper_ISNB:9781319228002 // Ebook_ISBN:: 9781319322342.

(***Español***) Nelson DL y Cox MM. **LEHNINGER. Principios de Bioquímica_7a Ed**. OMEGA (2018). ISBN: 9788428216678 (o ediciones anteriores).

2. (***English***) Berg JM, **Stryer L**, Tymoczko JL, Gatto G. **Biochemistry_9ª ed.** (2019) W.H.Freeman. ISBN

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9781319114657

(***Español***) Berg JM, Tymoczko JL, **Stryer L.** Bioquímica_7ª ed. REVERTE,. ISBN 9788429176025 (o ediciones anteriores).

3. **Mathews** CK, van Holde KE y Anthony-Cahill, SJ. **Bioquímica_4ª** Ed. Pearson, 2013. ISBN: 9788490353929

4. (***English***) **McKee** T y McKee JR. **Biochemistry: The Molecular Basis of Life_7th** ed. Oxford University Press (2019) ISBN- 9780190847609

(***Español***) **McKee** T y McKee JR. **Bioquímica: Las Bases Moleculares de la Vida,_7th** ed. McGrawHill Interamericana (2011) ISBN: 978-607-15-1440-0 (o ediciones anteriores)

(versión online free): https://accessmedicina.mhmedical.com/book.aspx?bookid=2971

5. ***(English)*** **Voet** D, Voet JG, Pratt CW. **Fundamentals of Biochemistry: Life at the Moelecular Level_5th** Ed. Wiley, (2016). ISBN: 978-1-118-91840-1 (o ediciones anteriores)

6. **Koolman** J y Roehm KH. **Bioquímica. Texto y Atlas_4ª** Ed. Panamericana, 2012. EAN: 9788498352153

7. Salway J.G. **Metabolism at a Glance, 4th ed**. Wiley-Blackwell. (2017) ISNB-13 978-0470674710

8. Gropper SS, Smith JL, Carr TP. **Advanced Nutrition and Human Metabolism, 8th Ed**. Cengage learning (2021) ISBN-13: 978-0357449813

PROBLEMAS

9. Cárdenas J, Fernández E, Galván F, Márquez AJ, Vega JM. **Problemas de Bioquímica**. Editorial Alhambra (1988)

INTERNET

10. Sociedad Española de Bioquímica y Biología Molecular

- SEBBM: http://www.sebbm.es/ http://www.sebbm.es/ES/bioquimica-y-universidad_11/

- **(Casos de medicina_free):** https://accessmedicina.mhmedical.com/cases.aspx?gboscontainerID=192

2. Further reading

1. Voet D y Voet JG. Bioquímica, 3ª Ed. Panamericana, 2006.

2. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M (2008): "Biología Celular y Molecular", 5ª ed. Editorial Médica

3. Castillo F, Roldán MD, Blasco R, Huertas MJ, Caballero FJ, Moreno-Vivián C y Martínez-Luque M. Biotecnología

Ambiental. Ed. Tébar, Madrid (2005).

4. Segel IH. Cálculos de Bioquímica. Ed. Acribia. 1982. INTERNET

1. Bioquímica en línea:

http://laguna.fmedic.unam.mx/

2. Life the Science of Biology W.H. Freeman

http://highered.mcgraw-hill.com/sites/dl/free/0072437316/120060/ravenanimation.html

3. Essential Study Partner for Biology McGraw Hill http://bcs.whfreeman.com/thelifewire/content/chp00/00020.html

4. Interactive Biochemistry by Rodney F. Boyer http://www.mhhe.com/biosci/esp/2001_gbio/requirements/default.htm

5. BioCourse.com McGraw Hill http://www.biocourse.com/mhhe/bcc/domains/content.xsp

6. zeroBio http://www.execulink.com/~ekimmel/

7. Pronunciation Guide ..... Prefixes Roots & Suffixes http://www.merck.com/mmhe/resources/pronunciations/index/a.html

8. Biology Animations BBC

http://www.bbc.co.uk/schools/gcsebitesize/teachers/biology/activities.shtml

9. Howard Hughes Medical Institute http://www.hhmi.org/biointeractive/

10. Chemistry Online Resource Essentials NCSSM

COURSE DESCRIPTION

COORDINATION CRITERIA

Joint activities: lectures, seminars, visits ...

SCHEDULE

Period	Assessment activities	Case study	Lab practice	Lectures	Seminar
1# Fortnight	0,0	0,0	0,0	4,0	0,0
2# Fortnight	0,0	2,5	0,0	4,0	0,0
3# Fortnight	0,0	5,0	0,0	4,0	0,0
4# Fortnight	0,0	5,0	3,0	4,0	0,0
5# Fortnight	0,0	5,0	0,0	4,0	0,0
6# Fortnight	0,0	5,0	0,0	4,0	0,0
7# Fortnight	3,0	0,0	3,0	4,0	2,5
8# Fortnight	0,0	0,0	0,0	4,0	0,0
9# Fortnight	0,0	5,0	3,0	4,0	0,0
10# Fortnight	0,0	5,0	0,0	4,0	0,0
11# Fortnight	0,0	2,5	0,0	4,0	0,0
12# Fortnight	0,0	2,5	0,0	4,0	0,0
13# Fortnight	0,0	2,5	0,0	6,0	0,0
14# Fortnight	3,0	0,0	0,0	6,0	2,5
Total hours:	***6,0***	***40,0***	***9,0***	***60,0***	***5,0***

The methodological strategies and the evaluation system contemplated in this Course Description will be adapted according to the needs presented by students with disabilities and special educational needs in the cases that are required.

CONTINGENCY PLAN: CASE SCENARIO A

Case scenario A will correspond to a diminished on-site academic activity due to social distancing measures affecting the permitted capacity of classrooms.

COURSE DESCRIPTION

METHODOLOGY

General clarifications on the methodology on case scenario A

A multimodal (hybrid) teaching system will be adopted, combining both on-site and remote classes via videoconference (synchronous) that will be held in the timetable approved by the corresponding Faculty or School. The time distribution of teaching activities (both on-site and remote) will be decided by the aforementioned Faculties and Schools bearing in mind the permitted capacity of classrooms and social distancing measures as established at that time.

Clarifications previously specified in the general methodology of this subject will also be taken into account.

EVALUATION

Intended learnig	Exams	Laboratory Practice	Problem solving
CB17v1	X	X	X
CE20v4	X	X	X
CE21v8	X	X	X
CE25v1	X	X	X
CE26v1	X	X	X
CU2	X	X	X
Total (100%)	***70%***	***10%***	***20%***
Minimum grade	***4***	***4***	***4***

(*)Minimum mark (out of 10) needed for the assessment tool to be weighted in the course final mark. In any case, final mark must be 5,0 or higher to pass the course.

Attendance will be assessed (Scenario A)?:

No

General clarifications on instruments for evaluation (Scenario A):

In the case of this scenario A, to pass the course it is an essential condition to achieve a final grade of 5 between the Theory grade and the Problem-solving grade, provided that the minimum has been exceeded in both sections. To this grade will be added, later, the grade of practices and seminars, if applicable. Additionally, the clarifications previously established in the assessment instruments are considered valid for the general evaluation of the subject

Clarifications on the methodology for part-time students and students with disabilities and special educational needs (Scenario A):

The clarifications previously established in the evaluation instruments are considered valid for the general

COURSE DESCRIPTION

evaluation of the subject

CONTINGENCY PLAN: CASE SCENARIO B

Case scenario B will bring about a suspension of all on-site academic activities as a consequence of health measures.

METHODOLOGY

General clarifications on the methodology on case scenario B

On-site teaching activities will be held via videoconference (synchronous) in the timetable approved by the corresponding Faculty or School. Alternative activities will be proposed for reduced groups in order to guarantee the acquisition of course competences.

Clarifications previously specified in the general methodology of this subject will also be taken into account.

EVALUATION

Intended learnig	Exams	Laboratory Practice	Problem solving
CB17v1	X	X	X
CE20v4	X	X	X
CE21v8	X	X	X
CE25v1	X	X	X
CE26v1	X	X	X
CU2	X	X	X
Total (100%)	***70%***	***10%***	***20%***
Minimum grade	***4***	***4***	***4***

(*)Minimum mark (out of 10) needed for the assessment tool to be weighted in the course final mark. In any case, final mark must be 5,0 or higher to pass the course.

Moodle Tools	Exámenes	Prácticas de laboratorio	Resolución de problemas
Cuestionario	X		X
Tarea		X	

Attendance will be assessed (Scenario B)?:

No

COURSE DESCRIPTION

General clarifications on instruments for evaluation (Scenario B):

In the case of this scenario B, to pass the subject it is an essential condition to achieve a final grade of 5 between the Theory grade and the Problem-solving grade, provided that the minimum has been exceeded in both sections. To this grade will be added, later, the grade of practices and seminars, if applicable. Additionally, the clarifications previously established in the assessment instruments are considered valid. general evaluation of the subject.

Clarifications on the methodology for part-time students and students with disabilities and special educational needs (Scenario B):

The clarifications previously established in the evaluation instruments are considered valid for the general evaluation of the subject