Course in which the cellular metabolism is developed, presenting the primary metabolism organized by catabolic and anabolic pathways, and with special emphasis on the regulatory mechanisms. In addition to the description of metabolism, it is intended to give a vision of its integration to evaluate the responses of a cell or organism to different environmental situations.

Competences (of the course placed in relation to the pre-assigned competences in the subject matter)

- That students know how to apply their knowledge to their work or vocation in a professional manner, and have acquired the competencies that allow them to elaborate and defend arguments as well as to solve problems within their area of study (CB2)
- Be able to understand and apply advanced knowledge of Biosciences and Engineering to the field of Biotechnology (E3)
- Be able to use tools, systems or processes to carry out the activities in the field of Biotechnology according to the established requirements (E4)

Previous Requirements * (modules, subject matters, courses or knowledge necessary for the follow-up of the subject. State previous courses required to be completed)

Knowledge of basic biology and biochemistry, having completed the subjects:
Cell and genetic biology
Animal and plant biology
Structure and function of Biomolecules

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CONTENTS (List the content of the course, with up to two level detail)

1.- Introduction to metabolism
   Metabolism and metabolic pathways
   Function of the ATP. Adenylate energy load
   Reducing power: NADH and NADPH
   Primary metabolism: general scheme
   Metabolic regulation: regulation of expression, compartmentalization, enzymatic regulation, hormonal regulation
   Experimental analysis of metabolism

2.- Carbohydrate metabolism. I. Catabolism
   Catabolism, anabolism, storage. General scheme.
   Glycolysis: metabolic pathway, regulation, metabolism of other sugars
   Fermentations: metabolic destinations of pyruvate
   Pentose phosphate pathway
   (Catabolism of glycogen: routes and regulation)

3.- Central oxidative processes of aerobic metabolism
   Pyruvate dehydrogenase complex
   Krebs cycle: citric acid cycle pathway. Regulation.
   Krebs cycle as an amphibolic pathway. Anaplerotic reactions
   Glyoxylate cycle
   Oxidative phosphorylation: ATP synthase complex
   Chemosmotic coupling: proton gradient, decouplers.
   Respiratory control
   Mitochondrial transport systems

4.- Carbohydrate metabolism. II. Biosynthesis
   Gluconeogenesis: pathway and regulation
   Krebs cycle and gluconeogenic precursors
   Glycogen biosynthesis.
   Glycogen metabolism: pathways and regulation
   Biosynthesis of aminosugars
   Biosynthesis of glycoconjugates
   Photosynthesis: Light and dark phases. Photorespiration

5.- Lipid metabolism
   Digestion, absorption and transport of fats
   Cholesterol: transport and use
   Oxidation of fatty acids
   Ketone bodies
   Lipid biosynthesis: fatty acids, membrane lipids, steroid hormones

6.- Amino acid metabolism
   * These features should not be modified without the approval of the academic board (subject matter, module and / or studies program).
Nitrogen cycle: nitrogen fixation and organic nitrogen biosynthesis
Protein recycling
Amino acid degradation: transamination and deamination
Urea cycle
Biosynthesis of amino acids. Overview

7.- Nucleotide metabolism
Biosynthesis of purines and pyrimidines
Metabolites activated by nucleotides
Degradation of nucleotides

8.- Transport across membranes
Dynamics of the membranes.
Transport of metabolites across membranes
Passive transport and active transport
Excitable membranes: neurotransmission

9.- Hormone regulation
Mechanisms of hormonal action
Hierarchy of hormonal control
Signal transduction systems

10.- Integration of the metabolism
Interdependence of organs in the metabolism in mammals

### METHODOLOGY

#### LEARNING ACTIVITIES *
* (Complete the table relating activities, workload in ECTS credits, and competences.)

<table>
<thead>
<tr>
<th>Learning Activities</th>
<th>ECTS Credits</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>1,4</td>
<td>CB2, E3, E4</td>
</tr>
<tr>
<td>Case and Problem-Solving Sessions</td>
<td>0,1</td>
<td>CB2, E3, E4</td>
</tr>
<tr>
<td>Seminars</td>
<td>0,1</td>
<td>CB2, E3, E4</td>
</tr>
<tr>
<td>Practical and Lab Work</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Presentations</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Personal Study</td>
<td>3,3</td>
<td>CB2, E3, E4</td>
</tr>
<tr>
<td>Assessment Tasks (Exams, Continuous Assessment...)</td>
<td>0,1</td>
<td>CB2, E3, E4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,0</strong></td>
<td><strong>CB2, E3, E4</strong></td>
</tr>
</tbody>
</table>

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TEACHING METHODOLOGY (justify the teaching methodology in relation to the competences and course contents. Between 100 and 200 words)

The subject is taught in class, combining lectures by the teacher and discussion seminars of the questionnaires and problems that complement each chapter of the subject. The subject is organized into chapters by thematic concepts.

- At the beginning of the course, students have the slides in the virtual campus for the development of the subject that will be presented in class by the teacher.
- At the beginning of the course, students are given the course schedule by topics and dates of the "seminars"
- During the course, 3 seminars will be held in which the "questionnaires of concepts and questions" of the chapters developed so far will be discussed.
- At the beginning of each chapter, the "questionnaire of concepts and questions" of the corresponding chapter will be accessible to the students, so that the students can work on the subject taught in class. It is essential that students consult the bibliography regularly using the "questionnaires of concepts and questions" as a working guide. These questionnaires will be delivered to the teacher at the end of the seminar *.
  * Students will attend the seminar with two copies of the solved questionnaire. One to be corrected in class and the other (uncorrected) that will be self-graded at the end of the seminar and delivered to the teacher.
- A seminar on general integration of the course and preparation for the final exam will be given at the end of the course

ASSESSMENT

ASSESSMENT METHODS * (Complete the table relating assessment methods, competences, and weight percentage in the course qualification)

<table>
<thead>
<tr>
<th>Assessment methods</th>
<th>Weight</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Exam</td>
<td>40%</td>
<td>CB2, E3, E4</td>
</tr>
<tr>
<td>Midterm Exam/s</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Continuous Assessment Activities</td>
<td>35%</td>
<td>CB2, E3, E4</td>
</tr>
<tr>
<td>Reports and Presentations</td>
<td>20%</td>
<td>E3, E4</td>
</tr>
<tr>
<td>Lab or Field Work</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Projects</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Host Student Evaluation</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>5%</td>
<td>E3</td>
</tr>
</tbody>
</table>

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LEARNING OUTCOMES  (Explanation of the student's achievements that allow the assessment of competences, relating them to the competences and the assessment methods)

• The student must demonstrate knowledge of the biochemical foundations and the bases of metabolism and its regulation. (→ CB2, MECES-1)
• The student must demonstrate proficiency to identify, formulate and solve metabolic problems (→ E3, MECES-2)
• The student must demonstrate the ability to assess the impact of Biochemistry and Biosciences on the sustainable development of society (E4)

QUALIFICATION  (Explanation of the qualification system)

<table>
<thead>
<tr>
<th>Evaluation methods</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE: Final exam</td>
<td>40%</td>
</tr>
<tr>
<td>FA: Follow-up activities</td>
<td>35%</td>
</tr>
<tr>
<td>RP: Reports and presentations</td>
<td>20%</td>
</tr>
<tr>
<td>P: Participation</td>
<td>5%</td>
</tr>
</tbody>
</table>

- The qualification of the follow-up activities (FA, 35% of the final grade) will be calculated as a simple average of the activities carried out during the course, consisting of the resolution of the questionnaires of each chapter that are organized in 4 deliveries at the end of the 4 discussion seminars throughout the course. The submission of all the completed questionnaires is mandatory in order to be able to take the final exam. The qualifications of the follow-up activities will not be reported during the course.

- The qualification of the Reports and presentations (RP, 20% of the final grade) will correspond to the "Metabolic pathways chart" that will be prepared during the course (in DINA3 format, written by hand), and that will be used in the final exam and will be delived together with the exam.

- The grade of the participation (P, 5% of the final grade) is awarded by the teacher at the end of the course, taking into account the level of participation that the student has had in the overall of the activities of the course.

- The final exam (FE, 40% of the final grade) aims to assess the synthesis of the subject.

The final grade (FG) of the subject will be calculated with the following formula: FG = 0.4 FE + 0.35 FA + 0.20 RP + 0.05 P.
To calculate the final grade according to the previous formula, the following must be fulfilled:

a) The final exam grade must be equal to or greater than 4.5
b) All "questionnaires of concepts and questions" must have been delivered
c) The "Metabolic pathways chart" will be delivered in the final exam.

If the grade of the final exam is lower than 4.5, the mark of the subject is that of the final exam.
In second call, the evaluation criteria are the same.

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ASSESSMENT OF THE COMPETENCES (Describe the grading system for each competence in relation with the assessment tasks)

For the evaluation of competence CB2, the final exam grade (70%) and grade of the follow-up activities (30%) will be used as indicator.

For the evaluation of competence E3, the indicator used will be the final grade for the subject.

For the evaluation of competence E4, the final exam grade (50%) and the presentation of the metabolic pathways chart (50%) will be used as an indicator.

BIBLIOGRAPHY (Recommended and accessible to the student.)

- Stryer, Bioquímica, Reverté
- Voet y Voet, Bioquímica, Ediciones Omega
- Mathews, van Holde, Ahern. Bioquímica, Addison Wesley
- Rawn, Bioquímica, McGraw-Hill Interamericana
- McKee y McKee, Bioquímica. La base molecular de la vida, McGraw-Hill

DOCUMENT HISTORY

PREVIOUS REVISIONS (Indicate date and author / s, first the most recent one)

CURRENT REVISION (Indicate date and author / s)
March 22, 2019, Prof. Antoni Planas

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