COURSE DATA

DATA SUBJECT

Code: 33133
Name: Bioenergetics
Cycle: Undergraduate Studies
ECTS Credits: 4.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1109 - Degree in Biochemistry and Biomedical Sciences	Facultat de Ciències Biològiques	2	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1109 - Degree in Biochemistry and Biomedical Sciences	Bioquímica	COMPULSORY

COORDINATION

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SUMMARY

Bioenergetics is a second year course of the degree in Biochemistry and Biomedical Sciences taught during the second quarter and consists of 4.5 ECTS. Activities related to this subject will be developed in classroom and laboratory practical classes.

Bioenergetics is the part of biochemistry that deals with the processes of transformation (transduction) forms of external energy (including visible light and chemical energy) into useful forms of energy for the cell. Their study is essential to the overall understanding of the biological function and is the necessary complement of subjects dealing with material flow (metabolism) and the flow of information (Molecular Biology). This course has a double orientation, first intended that students acquire a basic knowledge of central dogma, the "chemiosmotic theory" as well as the structure-function that allows the molecular machines perform different types of work, and second pay attention to different molecular alterations related environmental or energy transduction leading to various pathologies.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

There are no specified restrictions on enrollment with other subjects of the curriculum.

COMPETENCES / LEARNING OUTCOMES

1101 -

Aplicación de los conocimientos sobre estructura tridimensional de proteínas al estudio de la función de máquinas moleculares transductoras de energía.

Comprensión de leyes fenomenológicas como las termodinámicas mediante el manejo de funciones de estado.

Comprensión de una teoría bioquímica como la quimiosmótica, sus postulados así como su contrastación experimental.

Manejo de cálculos en bioenergética cuantitativa.

Manejo de medidas experimentales en el estudio de procesos bionergéticos en el laboratorio.

DESCRIPTION OF CONTENTS

1. Biomembranes and transport

Lipid bilayers. Liposomes and its clinical applications. Membrane proteins. Membrane dynamics. Membrane permeability. Thermodynamics of transport across the membrane.

2. Introduction to mediated transport

Transport systems: kinetics and classification. Techniques of study. Ionophores. Porous.

3. Ion channels

Characteristics of ion channels. Regulated opening channels. Physiological functions of the channels. Channelopathies.

4. Transporters

Rocker-switch transporters. Uniport. Symport. Antiport. Group translocators. Other carriers.

5. ATPases

Classification of ATPases. P-type ATPases: calcium ATPases, sodium and potassium ATPase and other P-type ATPases. ABC transporters. Importers and exporters, the transmembrane conductance regulator of cystic fibrosis and multidrug resistance. Type V ATPases: Mechanism, regulation and functions.

6. Chemiosmotic theory

Background and postulates of the chemiosmotic hypothesis. Peter Mitchell. The chemiosmotic proton circuit. Quantification of proton motive force. Energy-transducing membranes. Generators and consumers of the electrochemical gradient of ions. Sodium motive force.

7. ATP synthases

Types. Structure and composition of the ATP synthase type F. Rotational mechanism of catalysis. Role of proton motive force: transduction of osmotic energy to chemical energy. Operating mechanism of the interface a/c. Regulation. ATP synthases coupled to Na+ gradients.

8. Respiratory chains

Electron carriers of the respiratory chain. The tunnel effect. Organization and functioning of the mitochondrial electron transport chain. Generation of proton motive force: redox loops and H+ pumps. Functioning of mitochondrial respiratory complexes. Oxidative phosphorylation. Balances. Respiratory control. Inhibitors and uncouplers. Natural uncouplers. Role of mitochondria in apoptosis and degenerative diseases. Other respiratory chains.

9. Photosynthetic chains

Light absorption. Transduction of light energy into chemical energy: photooxidation. Functioning of a reaction center. Organization and functioning of bacterial photosynthetic chains. Photosynthetic chains based on two photosystems: energetic strategy. Proton motive force generation and ATP synthesis coupled. Balances.

10. Laboratory program

Session 1. Dissipation of the proton gradient in artificial vesicles. Preparation of phosphatidylcholine liposomes containing a fluorescent probe sensitive to pH changes inside, and study of the effect of a ionophore on the permeability of the membrane to protons.

Session 2. Determination of specific activity of cytochrome oxidase. Starting from a crude homogenate of rat liver and purified mitochondrias, extracts solubilized with detergent are prepared and the specific activity of cytochrome oxidase is determined.

Session 3. Study of the respiratory chain of liver mitochondria. Through measurements of oxygen consumption the order in which different substrates access to the mitochondrial respiratory chain and site of action of various inhibitors are investigated. A study on the proton circuit is also performed, inducing different states in mitochondrial respiration.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	27,00
Laboratory	11,00
Classroom practices	7,00

Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	5,00
Independent study and work	25,00
Preparation of lessons	37,50
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**67,50**

TEACHING METHODOLOGY

The development of the subject is divided into:

Theory classes: will be held with the full group of 80 students, twice a week. The teacher will develop, in each session, part of the thematic unit. The teacher will tell students the best resources for the subsequent preparation of the subject during the study time and individual work of the student non-attendance. The teacher will accessible when required, on the platform to support virtual classroom teaching, the material needed to properly follow the lectures, and indicate the most recommended resources for further preparation of the topic in greater depth.

Problems and questions classes: will be held in groups of 40 students. In them, students solve as directed by the teacher, problems of a collection of problems and issues prepared by the teacher of the subject and available in Virtual Classroom, for they will have to apply the knowledge gained in the lectures. The resolution and discussion will be hosted for the students, either individually or in groups coordinated by the teacher.

Laboratory classes: taught in groups of 16 students and are structured in three sessions. Attendance at practices is mandatory. Students attend the lab having read the scripts of practice, drawn up by teachers of the subject and available in Aula Virtual. During the session, Professor will guide the realization of the experiments. Students will complete a questionnaire, prepared by the teacher, with the results of each practice.

Interdisciplinary seminars: this activity will be organized jointly with the other subjects of the second degree course. The activity is the preparation and presentation of a seminar, lasting about 30 minutes, students in groups of two and active participation in the discussion of all the seminars. Students will complete the preparation and presentation of the seminar once during the school calendar. Conducting and assistance to interdisciplianry seminars is compulsory.

Individual tutorials: will review those that are more complex concepts of the course, both taught in the lectures and laboratory.

EVALUATION

Evaluation of the theoretical (theory, questions and problems):

- The result of this evaluation will be 8.0 points of the final grade for the course (80% of the final grade).
- The theoretical content will be evaluated by an exam divided into two parts: units 1-5 (thematic block I) and units 6-9 (thematic block II).
- The percentage representing each block on the theory will be 50% the first block, and 50% the second.
- The student approved the theory part if the average grade obtained between both blocks is equal or higher than 5 /10, with the two blocks approved, or one approved and one compensable (score equal to or greater than 4.5) .
- In the case of not passing the theory in the first call, the qualifications of the approved blocks will be saved only until the second call.
- In the case that the student has a compensable score in the two blocks after the first call, he must pass the exam in the second round of at least one of them to pass the theory.
- If you have passed the theory, but not practical, in the first call, the theory grade is saved only until the second call of the same academic year.
- In the exam of the second call the same considerations are valid for the examination of the first call.

Evaluation of the contents of laboratory practice:

- The result of this evaluation will be 1.5 points of the final grade for the course (15% of the final grade).
- To pass the course the student will have to approved the laboratory practices (score greater than or equal to 5/10).
- It will be evaluated by presenting a practical report.
- The practical report can only be submitted within the established period once the laboratory practice is completed.
- The work presented as a laboratory report must be original. Plagiarism, that is, copying or paraphrasing other people's texts, is not allowed. Professors will make use of the necessary tools to detect plagiarism. Plagiarism not only affects the honor of the student and the institution, but it is an illegal practice that will be academically penalized with a mark of zero in the activity.
- In case of passing the practices, but not the theory, the mark of practices will be kept for the three following academic years, and after this period, the practices must be carried out again.
- In the case of not passing the practices, not having delivered the practical report within the stipulated period or waive the saved score, the laboratory practices must be carried out again in the following course.

Evaluation of interdisciplinary seminar:

- The interdisciplinary seminar held as part of the activities shared by various disciplines represents 0.5 points the final course grade (5% of the final grade).
- Both the scientific content and the task of preparing the work and the ability to expose and discuss it publicly with peers and teachers will be evaluated, following the criteria established for

this purpose by the course coordinator.

Teaching activities:

- The attitude and participation of students in various educational activities of the course will be assessed. Class participation in theory, questions, problems and laboratory classes may modulate up to 5% of the score obtained in the corresponding block.
- Attendance at laboratory practice sessions is mandatory.
- Attendance at lectures, problems and questions is not compulsory but assessable.

Final statements:

- To pass this course the final score has to be equal to or greater than 5 points, having also met the above stated requirements.

REFERENCES

Basic references

- Nicholls, D.G. y Ferguson, S.J. Bioenergetics 4. Academic Press, 2013.
- Stryer, L., Berg, J.M. y Tymoczko, J.L. Bioquímica. Ed. Reverté. 7ª ed., 2013 (6ª ed. disponible en versión catalana).
- Nelson, D.L. y Cox, M.M. Lehninger. Principios de Bioquímica, Ed. Omega 7ª ed., 2018.
- Voet, D. y Voet, J.G. Bioquímica. Editorial Médica Panamericana, 3ª ed., 2006.
- Skulachev, V.P., Bogachev, A.V. & Kasparinsky F.O. Principles of Bioenergetics. Springer, 2013.
- Stein, W.D. y Lipman T. Channels, Carriers and Pumps. An Introduction to Membrane Transport, Academic Press, 2ª ed., 2015.
- White, S. , von Heijne, G., y Engelman, D. Cell Boundaries: How Membranes and Their Proteins Work, CRC Press, 2022.
- Specialized bibliography provided by the professor for each topic

Complementary references

- Peretó, J., Sendra, R., Pamblanco, M. y Bañó, C. Fundamentos de Bioquímica, Servei de Publicacions de la Universitat de València, 5ª ed., 2007 (also available in Valencian)
- Blankenship, R.E. Molecular Mechanisms of Phothosynthesis. Wiley-Blackwell, 2ª ed., 2014.
- Harris, D.A. Bioenegetics at a glace: An Illustrated Introduction. Blackwell Science Ltd, 1995.
- Alberts, B. y colaboradores. Biología Molecular de la Célula. Ediciones Omega, 6ª ed., 2016.
- Purves, D. y colaboradores. Neuroscience. Sinauer Associates Inc., 7ª ed., 2024.
- Byrne, J.H. y Roberts, J. L. From molecules to networks. An introduction to Celular and Molecular Neuroscience. Elsevier Academic Press. 3ª ed., 2014.