DEGREE CURRICULUM

METABOLIC BIOCHEMISTRY

Coordination: CABISCOL CATALA, ELISA

Academic year 2023-24

METABOLIC BIOCHEMISTRY 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>METABOLIC BIOCHEMISTRY</td></tr>
<tr><td>Code</td><td>101535</td></tr>
<tr><td>Semester</td><td>2nd 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 Biomedical Sciences</td><td>1</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRALAB</th><th>PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>0.6</td><td>2.4</td><td>3</td></tr>
<tr><td>Number of groups</td><td>3</td><td>2</td><td>1</td></tr>
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<tr><td>Coordination</td><td>CABISCOL CATALA, ELISA</td></tr>
<tr><td>Department</td><td>BASIC MEDICAL SCIENCES</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>Lectures/seminars/lab sessions: 60 h

Independent student work: 90 h</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Classes are taught mainly in Catalan

Additional information: English, Catalan and Spanish</td></tr>
<tr><td>Distribution of credits</td><td>TOTAL: 6 ECTS
1. Master class/Lectures: 3.0
2. Seminars / clinical cases: 1.8
3. Laboratory sessions: 0.6
4. Work Presentation (Discussion/Questions): 0,6</td></tr>
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METABOLIC BIOCHEMISTRY 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CABISCOL CATALA, ELISA	elisa.cabiscol@udl.cat	7,8	
PEDRAZA GONZÁLEZ, NIEVES	neus.pedraza@udl.cat	1,8	

Subject's extra information

Introduction to the subject and contextualization within the Biomedical Sciences degree

This first-year (second semester) subject is the continuation of the Structural Biochemistry course (first semester). It is especially important to understand the intermediary metabolism, the oxidative pathways and how cells obtaine energy. In addition, synthesis and degradation pathways of the main macromolecules will be studied. The relevant enzymes involved, their interrelations, regulations and how these metabolic pathways vary and adapt to the vital needs of the human organism will also be studied in this subject, as well as the regulatory role of the most important hormones in energy metabolism. This subject should allow to understand human metabolism and integrate all metabolic pathways of the human organism. The biomedical importance of each pathway and associated metabolic diseases are included.

It is complemented with subjects such as Structural Biochemistry, Physiology, Molecular Biology, Cellular Biology, and Chemistry.

Learning objectives

With regard to knowledge, the student that exceeds the subject must be able to:

1. Know the basic scientific terminology applied to biochemistry.
2. Recognize and classify the most important biomolecules that make up living things.
3. Understand the basic principles of bioenergetics and their importance in the metabolic pathways
4. Recognize the energy production mechanisms from basic foods.
5. Know and differentiate the main routes of carbohydrates, lipids, amino acids and nucleotides and their regulation.
6. Integrate the anabolic and catabolic pathways to have a global vision of metabolism.
7. Distinguish the role of the most relevant hormones in energy metabolism
8. Know the main dysfunctions as a result of alterations of the metabolic pathways, with emphasis in metabolic diseases.
9. Know the basic elements of a biochemistry laboratory and the basic work guidelines to ensure the reliability in the results and safety in the laboratory

In terms of procedure, the student that exceeds the subject must be able to:

1. Solve problems related to the biochemistry of human beings
2. Solve problems related to the normal or pathological function of metabolic pathways
3. Be able to use the basic elements of a biochemistry laboratory
4. Understand the concepts of concentration and know how to apply the dilution parameters.
5. Know how to use spectrophotometric techniques to calculate parameters of metabolic importance
6. Analyze and compare the experimental results and assess their importance and their limitations.
7. Work as a team in the resolution of problems and in the preparation of a presentation
8. Know how to collect basic information related to a topic, elaborate a summary and present it clearly to

colleagues.
9. Understand and critically evaluate basic scientific information related to human biochemistry

Competences

CB1 That students have demonstrated that they have and understand knowledge in an area of study that is based on general secondary education, and is usually found at a level that, while supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study

CB2 That students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the development and defense of arguments and problem solving within their area of study

CE7. Describe the mechanisms of synthesis and degradation of biomolecules and their regulation

CE8. Integrate or classify the molecular and metabolic bases of the functioning of the human body in relation to human pathology and therapeutic techniques.

CE18. Critically evaluate and use clinical and biomedical information technologies and sources to obtain, organize, interpret and communicate clinical, scientific and health information

CE19. Use laboratory material and apply basic laboratory techniques

CE39. Identify the indications for biochemical, hematological, immunological, microbiological, anatomopathological and imaging tests

CG5 Apply the gender perspective to the tasks of the professional field

Subject contents

THEORETICAL CURRICULUM - LECTURES (30h)

Topic 1. Introduction to bioenergetics (1h)

- Basic concept**s** of metabolism and metabolic pathways.
- Free energy. Standard free energy variation.
- Endergonic and exergonic reactions. Coupled reactions.
- Role of ATP and other phosphorylated compounds in metabolism.
- Main mechanisms of metabolic regulation

Topic 2. Citric acid cycle, electron transport chain and oxidative phosphorylation (4h)

- Acetyl-CoA: Structure and origin.
- Citric acid cycle and regulation.
- Anaplerotic reactions.
- Anabolic role of the citric acid cycle.
- Electron transport chain and oxidative phosphorylation.
- Translocase ATP-ADP.
- Energy efficiency.
- Uncoupling agents. Thermogenesis.
- Generation of toxic oxygen radicals. Physiological relevance.
- Mitochondrial diseases.

Topic 3. Carbohydrate metabolism (8h)

- Transport of glucose into the cell.
- Glycolysis: steps, regulation and energy balance. Metabolic associated diseases.
- Formation of acetyl-CoA: pyruvate dehydrogenase complex. Mechanism and regulation.
- Anaerobic glycolysis. Lactic fermentation and physiological relevance

- Glycogen metabolism. Regulation of glycogen synthesis and degradation. Glycogen storage diseases.
- Gluconeogenesis: precursors, reactions and regulation. Physiological relevance.
- Blood glucose control: role of different organs and tissues.
- Pentose phosphate pathway: steps and regulation. Physiological relevance. Glucose 6P dehydrogenase deficiency.
- Galactose metabolism. Clinical aspects: galactosemia
- Fructose metabolism. Disorders of fructose metabolism

Topic 4. Lipid metabolism (8h)

- Plasma lipoproteins: structure and function
- Mobilization of stored fats and oxidation of fatty acids. Activation, transport into the mitochondria and beta-oxidation. Energy yield and regulation.
- Peroxisomal oxidation of long-chain fatty acids.
- Ketones. Origin and regulation of ketogenesis. Physiological relevance.
- Fatty acid biosynthesis and regulation. Fatty acid synthase complex.
- Elongation and desaturation of fatty acids.
- Biosynthesis of triacylglycerides
- Specialized fatty acids. Eicosanoids: prostaglandins, thromboxanes and leukotrienes. Non-steroidal anti-inflammatory drugs
- Cholesterol: structure, biosynthesis and regulation.
- Transport of plasma cholesterol. LDL receptor.
- Dyslipidemia. Non-alcoholic fatty acid liver. Anticholesterolemic drugs
- Degradation of cholesterol. Bile acids and bile salts.

Topic 5. Amino acid and protein metabolism (4h)

- Overall nitrogen metabolism. Role of dietary proteins and essential amino acids.
- Protein turnover. Role of proteases and peptidases. Function of ubiquitin.
- Metabolism of the amino group of amino acids. Transamination and oxidative deamination. Clinical significance of transaminases.
- Urea cycle. Congenital diseases associated to the urea cycle.
- Ammonium metabolism. Hyperammonemia.
- Fate of carbon skeleton of amino acids: energy source.
- Biosynthesis of nonessential amino acids.
- Carrier molecules of one carbon units: S-adenosyl methionine, methyl cobalamin and tetrahydrofolate derivatives.
- Disorders of amino acid metabolism
- Specialized products derived from amino acids. Heme metabolism: porphyria and jaundice. Creatine, glutathione, nitric oxide, catecholamines, ...

Topic 6. Nucleotide metabolism (3 h)

- Role of dietary nucleic acids.
- Biosynthesis of purine nucleotides. De novo synthesis and salvage pathways.
- Degradation of purine nucleotides. Uric acid. Hyperuricemia and gout.
- Congenital metabolic disorders of purine nucleotides.
- Pyrimidine biosynthesis and degradation.
- Deoxyribonucleotides biosynthesis. RNR reductase and regulatory mechanisms.
- Synthesis of thymidine monophosphate.
- Structure and function of antineoplastic drugs.

Topic 7. Integration of metabolism (2 h)

- Hormones involved in energy metabolism: insulin, glucagon and adrenaline. Physiological role and regulation.
- Daily energy expenditure. Basal metabolic rate.
- Metabolic fuels in humans.
- Metabolic profile in the well-fed state.

- Metabolic adaptation to fasting.

SEMINARS AND CLINICAL CASES (18 h)

Seminars: Examples:

1. Liquid Chromatography
2. Glycogen storage diseases
3. Physical exercise. Food, dietary supplements and "Dopping"
4. Iron metabolism
5. Ethanol metabolism
6. Cancer cells metabolism

Clinical cases: list of clinical cases related with metabolic pathologies or biochemically relevant

TEAMWORK (6 h)

Groups of 2-3 students will present a topic of metabolic interest in poster format

LABORATORY SESSIONS (6h)

Lab 1. Iron metabolism (2 h)

- Measurement of total iron concentration from serum
- Measurement of total Iron-binding capacity (TIBC)
- Comparison and discussion of the results

Lab 2. Glycemic control (2 h)

- Measurement of fasting glucose.
- Determination of glycated hemoglobin by ion exchange chromatography.
- Comparison and discussion of results.

Lab 3. Cardiovascular risk assessment (2 h)

- Determination of total cholesterol and HDL cholesterol from human serum by spectrophotometric techniques.
- Prediction of coronary risk. The Framingham study
- Comparison and discussion of results.

Methodology

THEORETICAL CURRICULUM - LECTURES (30 h)

Master classes where the fundamental contents of the subject will be explained.

SEMINARS AND CLINICAL CASES (18 h)

Seminars: a series of seminars will be held that may change depending on the importance on the subject, news, impact, and when applicable, student interest.

Clinical cases: a list of clinical cases related to metabolic diseases or biochemical interest will be submitted for discussion and will be solved by the students based on the knowledge acquired during the course.

TEAMWORK (6h)

It will be done in groups of 2-3 students. Each group will be assigned with a topic of metabolic interest (metabolic

disease, diet, xenobiotic, sport, ...).

Students will present their work in a poster format and they will do an oral presentaion (5 min). After, they will answer a set of questions (8-10 min)

LABORATORY SESSIONS (6 h)

Three laboratory sessions will be carried out in small groups (15-16 students) so that students understand and are able to correctly use some of the basic elements that are part of a clinical analysis with metabolic relevance.

Basic working patterns to ensure reliability and safety results in the laboratory will be provided.

It is mandatory for students to bring to all laboratory sessions :

- White lab coat (UdL)
- Safety glasses

They can be adquired at the UdL store (**ÚDELS)**. Centre de Cultures i Cooperació Transfronterera – Campus Cappont. Carrer de Jaume II, 67 baixos. 25001 Lleida

Failure to wear the PPE (personal protection equipment) described or failure to comply with the general safety rules listed below will result for the student not being able to access the laboratory or having to leave it.

GENERAL SAFETY RULES IN LABORATORY SESSIONS

- Maintain the place of performance of clean and tidy practices. The work table must be free of backpacks, folders, coats ...
- In the laboratory you can not come with shorts or short skirts.
- Bring closed and covered shoes during the performance of the practices.
- Bring long hair always collected
- Keep the gowns cords to protect against spills of chemical substances.
- Do not wear wide bracelets, pendants or sleeves that can be trapped by the equipment.
- Avoid wearing contact lenses, since the effect of chemicals is much greater if they are introduced between the contact lens and the cornea.
- Do not eat or drink in the laboratory
- Smoking is prohibited within laboratories
- Wash your hands whenever you have contact with a chemical and before leaving the laboratory.
- Follow the teacher's instructions and consult any questions about security

Development plan

THEORETICAL CURRICULUM - LECTURES (30 h)

Master classes in a single group of 50-55 min that will be distributed throughout the semester

SEMINARS AND CLINICAL CASES (18 h)

Seminars and classes of clinical cases of a single group, of about 100 min (2 of 50 min with 10 min rest)

TEAMWORK (6h)

At the beginning of the course, each group of students will be assigned with a topic of metabolic interes. General work guidelines will be given.

LABORATORY (6 h)

There will be 3 lab sessions of 2 hours each, distributed throughout the course as the theoretical concepts necessary to understand the practice are introduced.

They will be carried out in small groups allowing the necessary distancing (3 groups of 15-16 people).

Evaluation

FIRST PARTIAL TEST: 3.8 points*

Written test with test or similar questions (V / F, pairings, complete sentences, ...) and short answer questions on contents and basic concepts of the theoretical syllabus and seminars.

SECOND PARTIAL TEST: 4.0 points*

Written exam with test-type questions or similar (V / F, pairings, complete sentences, ...), short answer questions on contents and basic concepts of the theoretical syllabus and seminars and resolution of clinical cases.

* the punctuation of each part may vary depending on the content included in each exam

TEAMWORK: 1.2 points

The oral presentation of the work and the answers to the questions posed will be evaluated (0.8 points)

There will be a written exam with multiple choice questions for each topic presented (0.4 points)

LABORATORY PRACTICES: 1,0 point

Written exam with short answer questions and problems related to laboratory practices

TUTORING: make an appointment

Highest score: 10 points

- • Fail: <5 points
- • Approved: from 5 to 6.99 points
- • Notable: from 7 to 8.99 points
- • Excellent: > 9 points
- • Excellent-MH: the two best grades with > 9 points

- Teamwork and laboratory practices are not recoverable.

- The final mark of the subject will be the weighted average of all the parts of the subject.

- The course will be approved if the weighted average is equal to or greater than 5.

- If 1 of the two partial exams is failed with a grade greater than or equal to 4.5, it will not be necessary to repeat it.

- If 1 partial is suspended with a grade lower than 4.5, it will be mandatory to recover it. The average will not be done. With the mark obtained in the make-up exam, plus the rest of the marks, the student will pass if the weighted average is equal to or greater than 5.

- If the two partials are suspended, both must be recovered. With the mark obtained in the make-up exam, plus the rest of the marks, the subject will be approved if the weighted average is equal to or greater than 5.

- The student who attends the recovery to raise the grade, will have the grade of the last exam.

Bibliography

Basic bibliography

1. Baynes JW, Dominiczak MH. 2019. Bioquímica Médica. 5ª edición. Ed. Elsevier

2. Champe PC, Harvey RA, Ferrier DR. 2005. Bioquímica. 3a edición. Ed. Mc Graw-Hill Interamericana

3. Devlin TM. 2015. Bioquímica. Libro de texto con aplicaciones clínicas. 4a edición. Ed. Reverté. (7th edition in english available)

4. Feduchi et al. 2020. Bioquímica. Conceptos esenciales. 3ª edición. Ed. Médica Panamericana

5. Ferrier DR. 2013. Biochemistry. Lippincott's Illustrated Reviews. 6th ed. McGraw-Hill

6. Gaw et al. Bioquímica clínica. 2019. Texto y atlas en color. 6ª edición. Ed. Elsevier

7. Mathews CK, et al. 2013. Bioquímica. 4ª edición. McGraw-Hill Interamericana.

8. Rodwell VW, et al. 2018. Harper's Illustrated Biochemistry. 31th edition. Ed. McGraw-Hill Education

9. Nelson DL, Cox MM. 2018. Lehninger. Principios de Bioquímica. 7a edició. Ed. Omega.

10. Scriver CR, et al. 2001. The Metabolic & Molecular Basis of Inherited Disease. 8th Ed. McGraw-Hill. 4 vol.

11. Strayer L, Berg J, Tymoczko J. 2018. Bioquímica. 9a edición. Ed. Reverté.

12. Strayer L, Berg J, Tymoczko J. 2014. Bioquímica. Curso básico. Ed. Reverté.

13. Voet D, Voet JG, Prat CW. 2016. Fundamentos de Bioquímica. 4a edición Editorial Médica Panamericana

Scientific journals (library)*:*

1. Investigación y Ciencia

2. New England Journal of Medicine

3. Physiological Reviews

4. The Lancet