



Universitat de Lleida

DEGREE CURRICULUM
METABOLIC BIOCHEMISTRY

Coordination: CABISCOL CATALA, ELISA

Academic year 2020-21

Subject's general information

Subject name	METABOLIC BIOCHEMISTRY			
Code	101535			
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION			
Typology	Degree	Course	Character	Modality
	Bachelor's Degree in Biomedical Sciences	1	COMMON	Attendance-based
Course number of credits (ECTS)	6			
Type of activity, credits, and groups	Activity type	PRALAB	PRAULA	TEORIA
	Number of credits	1.5	1.5	3
	Number of groups	2	2	1
Coordination	CABISCOL CATALA, ELISA			
Department	BASIC MEDICAL SCIENCES			
Teaching load distribution between lectures and independent student work	Lectures/seminars/lab sessions: 60 h Independent student work: 90 h			
Important information on data processing	Consult this link for more information.			
Language	Classes are taught mainly in Catalan			
	Additional information: English, Catalan and Spanish			
Distribution of credits	TOTAL: 6 ECTS 1. Master class/Lectures: 3.2 2. Seminars / clinical cases: 1.6 3. Laboratory sessions: 0.6 4. Work Presentation (Discussion/Questions): 0,6			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CABISCOL CATALA, ELISA	elisa.cabiscol@udl.cat	7,8	
PEDRAZA GONZALEZ, NIEVES	neus.pedraza@udl.cat	1,2	

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 obtain 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

Competences of the Curriculum

- Understand the structure and function of biomolecules
- Understand the mechanisms of synthesis and degradation of biomolecules.
- Integrate metabolic and molecular bases of functioning of the human organism with regard to human pathology and therapeutic techniques.
- Understand, critically evaluate and know how to use technologies and sources of clinical and biomedical information to obtain, organize, interpret and communicate clinical, scientific and health
- Manage materials and basic laboratory techniques

Subject contents

THEORETICAL CURRICULUM - LECTURES (32h)

Topic 1. Introduction to bioenergetics (2h)

- Basic concepts 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 (3 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 (22 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)

In groups of 2 students of a disease with metabolic interest / sport / diet, ..

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 (32 h)

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

SEMINARS AND CLINICAL CASES (12 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 students. Each group will look for a person (within the family, friendship or acquaintance, ...) who has a disease of metabolic interest. It can also be carried out on people who carry out a specific diet or sport.

The students will carry out a written work where they will present their case in poster format.

At the end of the course, there will be a session where questions will be raised about the written presentation and the proposed topic.

LABORATORY SESSIONS (6 h)

There will be 3 laboratory sessions in small groups (10-12 students): students can know and are able to correctly

measure some of the basic elements that are part of a clinical analysis and which are of special 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
- Gloves for chemical and biological protection
- Mask

They can be acquired at the UdL store (**UDEL**S). Centre de Cultures i Cooperació Transfronterera – Campus Capponet. 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

SPECIFIC RULES FOR COVID 19

Students will be properly informed before carrying out these laboratory sessions, depending on the health situation and the regulations that derive from it.

Development plan

THEORETICAL CURRICULUM - LECTURES (32 h)

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

They will be performed face to face (in person) according to classrooms availability

SEMINARS AND CLINICAL CASES (12 h)

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

All hours will be taught virtually (online) through synchronous classes (live by video conference)

Seminars and clinical cases will be combined so that they parallel with the theoretical lectures.

TEAMWORK (6h)

Students will indicate the topic they intend to raise with the teacher before starting and will be given a series of

general work guidelines.

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 face-to-face and will be carried out in small groups allowing the necessary distancing (4 groups of 10-12 people).

THE POSSIBILITY OF TEACHING THE SCHEDULED FACE-TO-FACE CLASSES WILL ALWAYS BE DEPENDING ON THE EVOLUTION OF THE COVID 19 PANDEMIC AND THE DERIVATIVE REGULATIONS.

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 written work presented (poster) and the answers to the questions posed will be evaluated

LABORATORY PRACTICES: 1 point

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

TUTORING: make an appointment

DEPENDING ON THE EVOLUTION OF THE COVID19 PANDEMIC AND IF THE TEACHER CONSIDERS IT NECESSARY, THE TYPE OF EVALUATION MAY VARY

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

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 edició. Ed. Reverté. (7th edition in english available)
4. Ferrier DR. 2013. Biochemistry. Lippincott's Illustrated Reviews. 6th ed. McGraw-Hill
5. Mathews CK, et al. 2013. Bioquímica. 4ª edición. McGraw-Hill Interamericana.
6. Rodwell VW, et al. 2018. Harper's Illustrated Biochemistry. 31th edition. Ed. McGraw-Hill Education
7. Nelson DL, Cox MM. 2018. Lehninger. Principios de Bioquímica. 7a edició. Ed. Omega.
8. Scriver CR, et al. 2001. The Metabolic & Molecular Basis of Inherited Disease. 8th Ed. McGraw-Hill. 4 vol.
9. Strayer L, Berg J, Tymoczko J. 2018. Bioquímica. 9a edición. Ed. Reverté.
10. Strayer L, Berg J, Tymoczko J. 2014. Bioquímica. Curso básico. Ed. Reverté.
11. 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