Universitat Autònoma de Barcelona

2022/2023

Clinical Biochemistry

Code: 101912
ECTS Credits: 6

Degree	Type	Year	Semester
2501230 Biomedical Sciences	OB	3	2

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Josefina Mora Brugues
Francisco Blanco Vaca
Alfredo Jesús Miñano Molina

Prerequisites

The prerequisites to follow the course are a working knowlegde of the material of the courses "Structure and function of biomolecules" and "Metabolism of biomolecules" of the 1st year of the degree. Furthermore, although not official, it is advisable to have passed the course "Physiology of systems".

Objectives and Contextualisation

Clinical Biochemistry is a mandatory course of the 3rd year of the degree.

Clinical Biochemistry aims to initiate the student in understanding the *in vitro* study of the biological properties that contribute to the prevention, diagnosis, prognosis and monitoring of diseases and disease states in humans.

The general objectives of the course are:

1) Familiarize students with the specific characteristics of a laboratory of clinical biochemistry.
2) Understanding the pathophysiology and molecular basis of the most prevalent diseases.
3) Know the analytical methods commonly used in the clinical laboratory.
4) Know how can contribute the clinical laboratory to assess the health status of individuals.

At the end of the course the student will know: the pathophysiological bases of the most relevant and prevalent diseases in our population; the main biological properties that are altered in these diseases and are examined in a clinical biochemistry laboratory; the procedures for the biological properties measurement and test; and

their semiologic characteristics. It will also be familiar with the use of tools for the operation in a clinical biochemistry laboratory: instructions or work protocols, implementation of internal control quality program, participation in an external quality evaluation programs and use of automated measurement systems.

Competences

- Display knowledge of the bases and elements applicable to the development and validation of diagnostic and therapeutic techniques.
- Read and critically analyse original and review papers on biomedical issues and assess and choose the appropriate methodological descriptions for biomedical laboratory research work.
- Use bioinformatic tools, databases and methods for analysing experimental data.
- Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Learning Outcomes

1. Analyse information from experimental studies and clinical trials.
2. Define the concepts and fundamental principles of a clinical laboratory (premetrological, metrological and postmetrological variability, measurement error, uncertainty, quality control, semiology).
3. Identify the principal analytical procedures used to determine biochemical magnitudes.
4. Interpret the results of biochemical markers used for screening, diagnosis, prognosis and monitoring of the most common pathological disorders (diabetes, hypercholesterolemia, cardiopathies, hepatopathies).
5. Perform basic techniques in clinical biochemistry.
6. Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Content

Theme I. Metrological and semiological aspects of clinical laboratory

INTRODUCTION. Concepts. Pre-analytical, analytical and post-analytical phases of the clinical laboratory. Collection, preparation and preservation of specimens. Pre-analytical variability.

METROLOGY. Values and quantities, observations and measurements. Measures and errors. Random error: precision. Systematic error: trueness. The true value. Calibration and traceability. Specificity. Error of measurement: accuracy and uncertainty. Measuring analytical range. Analytical sensitivity. Detectability.

QUALITOLOGY. Control materials. Basis of internal control: control rules and charts. Algorithms. External quality assessment programs.

BIOLOGICAL VARIABILITY AND REFERENCE VALUES. Intra- and inter-individual biological variability. Theory of reference values. Transversal and longitudinal comparisons. Production of reference values.

SEMIOLOGY. Discriminant capacity. Cut-off value. Diagnostic sensitivity and specificity. Prevalence and predictive value. Likelihood ratio. Receiver operating curves (ROC).

Theme II. Biochemical assessment of metabolic pathways

PROTEINS. Classification of plasma proteins. Methods of identification, detection and quantification. Identification of electrophoretic profiles. Hyperproteinemia and hypoproteinemia. Polyclonal and monoclonal hyperimmunoglobulinemia. Paraprotein.

ENZYMES. Diagnostic usefulness of measuring plasma enzymes. Measuring the catalytic concentration and the mass concentration. Transformation and factors that affect it. Calibration. Standardization measures. Major

diagnostic enzymes of interest.

CARBOHYDRATES. Hormonal control of glucose homeostasis. Hyperglycemia and diabetes mellitus and alterations in glucose tolerance. Procedures for measuring glucose, hemoglobin A1c and albumin in urine.

LIPOPROTEINS. Structure and classification of plasma lipoproteins. Procedures for the study of dyslipidemia: total cholesterol and triglyceride. Separation of lipoproteins, VLDL cholesterol, HDL and LDL. Apolipoproteins. Classification of dyslipidemia. Genetic basis. Atherothrombosis: coronary heart disease and risk factors.

CALCIUM. Hormonal regulation of calcium homeostasis. Hypercalcemia and hypocalcemia. Bone metabolism. Biochemical markers of bone formation and resorption. Metabolic bone. Procedures for measuring biochemical markers of mineral metabolism.

ACID-BASE BALANCE. Homeostasis acid-base: blood pH buffers. Origin of pH variations. Compensatory mechanisms. Determination of pH, pCO_2 and pO_2. Alterations of the acid-base balance. Respiratory and metabolic acidosis and alkalosis.

Theme III. Biochemical assessment of the function of organs and systems

LIVER FUNCTION. Hepatobiliary system. Liver functions. Catabolism of hemoglobin. Hepatobiliary disease. Laboratory tests for evaluation. Investigation of jaundice: bilirubin determination.

CARDIAC AND MUSCULAR FUNCTIONS. Myocardial infarction and angina. Mechanisms. Meaning diagnostic procedures and measuring creatine kinase and its isoenzymes, myoglobin and troponin. Natriuretic peptides in the diagnosis of heart failure. Myopathies: progressive muscular dystrophy, rhabdomyolysis and polymyositis.

RENAL FUNCTION. Formation of urine and renal functions. Kidney disease: glomerulonephritis, tubular diseases, kidney failure, diabetic nephropathy, renouretral lithiasis. Laboratory tests for evaluation: urea, creatinine, urate, clearance testing, protein and kidney stones.

THYROID FUNCTION. Thyroid. Synthesis, transport, metabolism and regulation of thyroid hormones. Hypothyroidism and hyperthyroidism.

GONADAL AND GESTATIONAL FUNCTIONS. Ovarian function. Hormonal studies: prolactin, estradiol, progesterone, androgen and gonadotropins. Evaluation of infertility. Testicular function. Alterations: hypogonadism, infertility, disorders of puberty. Diagnosis and monitoring of pregnancy. Evaluation of fetus-placental unit.

BIOCHEMISTRY OF CANCER AND TUMOR MARKERS. Concept and classification. Clinical utility. Dynamic interpretation of the results. Main markers: CEA, AFP, b-hCG, PSA, CA19.9, CA125 and CA15.3. Application in different types of tumors. Concept of hereditary cancer. Oncogenes and tumor suppressor genes.

LABORATORY PRACTICES

Session 1

Measures by molecular absorption spectrometry in an analyzer: (1) Measurement of the substance concentration of cholesterol in serum through an enzymatic-colorimetric reaction to an end-point. (2) Measurement of the substance concentration of urea in serum by a two points enzymatic reaction-spectrometric. (3) Measurement of the catalytic activity of L-lactate dehydrogenase (LD) in serum using a continuous spectrometric method recommended by the $SEQC^{ML}$ (Spanish Society of Medical Laboratory). Measuring the substance concentration of total bilirubin in serum through a chemical reaction by molecular absorption spectrometry: Measurements with blank sample. Implementation of an external quality assessment program using the obtained results.

Session 2

Measurement of the catalytic activity of L-lactate dehydrogenase (LD) in serum using a continuous spectrometric method recommended by the IFCC (International Federation for Clinical Chemistry and Laboratory Medicine) in a molecular absorption spectrometer: Comparison of two procedures and influence of the measuring instrument.

Session 3

Study of the effect of interfering substances (hemoglobin, bilirubin and lipids) in the measurement of the substance concentration of uric acid in serum using an end-point enzymatic procedure in a molecular absorptionspectrometer.

Session 4

Determination of the linearity and the latency periods of the enzymatic reaction catalyzed by aspartate aminotransferase (AST) using a continuous spectrometric method: Effect of pyruvate in the measurement of the enzyme.

Methodology

The teaching methodology consists of lectures, seminars and laboratory practices. The teaching materials for these activities can be found on the Virtual Campus.

Lectures: taught in master classes where students acquire basic knowledge of the subject by attending classes and supplementing them with individual study of the topics explained. The lectures are for the whole group.

Seminars: discuss, develop and present case studies, clinical cases and problems. The knowledge acquired in the lectures and individual study will be applied to solve cases and problems. Students work in small groups supervised by the teacher, solving proposed cases and after exposing them to class. The aim of the seminars is to promote the capacity for analysis and synthesis, the critical reasoning and the ability to solve cases and problems.

Laboratory practices: practical sessions in the laboratory where they apply the knowledge acquired in the lectures and promote learning practical techniques of clinical biochemistry laboratory. It promotes teamwork and active self. Students work in small groups. This activity is mandatory. To attend the sessions the student must have passed the biosafety and safety tests found in the Virtual Campus and to be aware and accept the rules of operation of the laboratories of the Faculty of Biosciences.

Additionally students can have specific tutorials.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practices	9	0.36	1, 5, 6
Lectures	36	1.44	2, 3, 4
Seminars	10	0.4	1, 2, 3, 4, 6
Type: Supervised			
Group tutorials	2	0.08	2, 3, 4

Type: Autonomous			
Evaluation (exams and oral presentations)	10	0.4	1, 2, 3, 4, 5, 6
Individual study	51	2.04	1, 2, 3, 4, 5
Solving problems and practical cases	20	0.8	1, 4, 6

Assessment

Evaluation activities

The assessment of the course is continuous and will be evaluated both individually and in group activities. All assessment activities are obligatory. None of the assessment activities represent more than 50% of the final grade.

(1) 1t Midterm exam (30 % of the final grade), written tests on basic concepts of the course. The type will be multiple choice questions (50 %) and short questions (50 %) of the subjects developed in the lectures. It is necessary that the mark of the test is $\geq$ 4.7 to overcome it.

(2) 2d Midterm exam (30 % of the final grade), written tests on basic concepts of the course. The type will be multiple choice questions (50 %) and short questions (50 %) of the subjects developed in the lectures. It is necessary that the mark of the test is $\geq$ 4.7 to overcome it.

(3) Test problems (10 % of the final grade), evaluation of the problem classes. There is no possibility of re-assessment.

(4) Clinical case (15 % of the final grade), consists of two parts: presentation of the case (10 %) in group of two students or individually, content and oral presentation and writing is evaluated; the clinical case presented must be submitted through the Virtual Campus in the deadline. The cases presented but not submitted are not evaluated. To get the remaining 5 % the student must participate by asking questions about the cases presented in class and at the request of the teacher. There is no possibility of re-assessment.

(5) Laboratory practices (15 % of the final grade), evaluation of the practical results obtained in the laboratory sessions (5 %) and a final written test (10 %). The practices are mandatory. There is no possibility of re-assessment.

Re-assessment exam (60 % of the final grade), for those students who have not passed the midterm exams or who want to mark up. The examination will be the entire subject matter (no individual midterm re-assessment). The type will be multiple choice questions (50 %) and short questions (50 %) of the subjects developed in the lectures and seminars. It is necessary that the mark is $\geq$ 4.7 to overcome it. To be eligible for the retake process, the student should have been previously evaluated in a set of activities equaling at least two thirds of the final score of the course or module. Thus, the student will be graded as "No Avaluable" if the weighthin of all conducted evaluation activities is less than 67% of the final score.

You must consider:

To pass the course you must get at least $\geq$ 5.0 in the final mark. The non-execution of any of the assessment activities is a zero in that activity.

Total or partial plagiarism from any other source in any assessed activity will automatically to be considered as a fail.

Repeating students keep marks of the test problems and clinical case activities evaluated for the next academic course. If students do not pass the course in this period, they must return all seminars activities.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
1t Midterm exam	30 %	3	0.12	2, 3, 4
2d Midterm exam	30 %	3	0.12	2, 3, 4
Clinical cases	15 %	2	0.08	1, 2, 6
Laboratory practice	15 %	3	0.12	1, 4, 5, 6
Problems	10 %	1	0.04	1, 2

Bibliography

Books

BIOQUÍMICA CLÍNICA Y PATOLOGÍA MOLECULAR. X Fuentes Arderiu, MJ Castiñeiras Lacambra, JM Queraltó Compañó. Volums I and II, 2nd ed. Editorial Reverté: Barcelona, 1998

CLINICAL BIOCHEMISTRY. A Gaw, R Srivastava. Netherlands: Elsevier Health Sciences, 2013 (e-book)

CLINICAL CHEMISTRY. WJ Marshall, M Lapsley. Edinburgh: Elsevier, 2016 (e-book)

HENRY'S CLINICAL DIAGNOSIS AND MANAGEMENT BY LABORATORY METHODS. Volums 1 and 2. Elsevier UK, 2016

TIETZ FUNDAMENTALS OF CLINICAL CHEMISTRY AND MOLECULAR DIAGNOSTICS. CA Burtis, DE Bruns, eds. 7th ed. Elsevier Saunders: St. Louis, MO, 2015

TIETZ TEXTBOOK OF CLINICAL CHEMISTRY AND MOLECULAR DIAGNOSTICS. N Rifai, AR Horvath and CT Wittwer, eds. 6th edition. Elsevier: St. Louis, MO, 2018 (reference book)

Web pagesrelated to the clinical laboratory (see the Virtual Campus)

Software

There is no specific software for this course