



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Biochemistry

2425-2-H4101D006-H4101D016M

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#### Aims

The module main objective is to provide students with the concepts necessary for understanding biological phenomena and the energetic variation associated with them. The course will focus on how to place the molecular basis for understanding the complex processes underlying the metabolism of living creatures

#### Contents

Introduction to biochemistry.

Bioenergetics.

Enzymology. Diagnostic use of enzymes and isoenzymes. Bioenergetics: respiratory chain and oxidative phosphorylation. Glucose metabolism: digestion, absorption. Aerobic and anaerobic glycolysis. Regulation of glycolysis. Glycogen synthesis and glycogenolysis and regulation. Galactose and fructose metabolism.

Lipid metabolism: digestion and absorption. Catabolism of lipids. Citric acid cycle. Lipogenesis. Regulation of lipolysis and lipogenesis. Metabolism of cholesterol and its derivatives. Metabolism of ketone bodies. Lipoprotein metabolism of plasma lipoproteins.

Protein metabolism: digestion, absorption, and transport of amino acids. General metabolism of amino acids. Urea cycle. Gluconeogenesis and its regulation.

Purine and pyrimidine metabolism.

Hormones metabolism

Organ biochemistry. Blood, Liver, Kidney, Central Nervous System, Muscle tissue, Adipose tissue

#### Detailed program

Bioenergetics - Respiratory chain and oxidative phosphorylation. Use of the energy released in biological oxidation-

reductions for the formation of molecules with high energy content. Main control mechanisms. The P/O ratio. The production of ATP. ATP reactions. The energetic charge. Inhibitors and uncouplers of oxidative phosphorylation. Mitochondrial dysfunctions.

Enzymology - Enzymatic catalysis. Enzyme kinetics. Meaning of  $V_{max}$  and  $K_m$ . Factors that influence enzymatic activity. Inhibitors. Metabolic inhibition. Feedback inhibition. Product inhibition and regulation of metabolic pathways. Drugs as enzyme inhibitors. Criteria and techniques for measuring enzymatic activity. Isoenzymes. Diagnostic use of enzymes and isoenzymes.

Carbohydrates Metabolism - Digestion, absorption and transport of carbohydrates. Role of dietary fiber and notes of the microbiota. Aerobic and lactic glycolysis. Metabolic and hormonal regulation of glycolysis. ATP yield. Metabolism of 2,3 diphosphoglycerate. Hexosomonophosphate shunt. Glucose 6-P dehydrogenase. Ribose production. Interconversion of sugars. Galactose and fructose metabolism. Galactosemia. Blood sugar regulation. Glycogen metabolism. Glycogen synthesis and glycogenolysis. Liver and muscle glycogen. Glycogen storage diseases. Metabolic and hormonal regulation of glycogen metabolism and glycemia and diabetes mellitus.

Lipid metabolism - Digestion and absorption of lipids. Catabolism of lipids. Lipolysis. Lipases.  $\beta$ -oxidation of fatty acids. Role of carnitine. ATP yield. Krebs cycle. Reactions of the citric acid cycle. ATP yield and relationships with the respiratory chain. Lipid anabolism; Lipogenesis: biosynthesis of fatty acids; synthesis of unsaturated and polyunsaturated fatty acids; biosynthesis of triglycerides. Regulation of lipolysis and lipogenesis. Metabolism of cholesterol and its derivatives. Food-derived cholesterol. Cholesterol biosynthesis. Regulation of cholesterol synthesis. Conversion of cholesterol into neutral sterols and bile salts. Metabolism of complex lipids. Metabolism of glycerophospholipids and sphingolipids. Ketogenesis and its regulation. Metabolism of ketone bodies. Plasma lipoproteins and lipid transport. Lipoprotein metabolism. Apolipoproteins. Transport of exogenous lipids via chylomicrons. Transport of endogenous lipids by VLDL, IDL and LDL. HDL and reverse cholesterol transport. Lipoprotein receptors. Dyslipidemias.

Protein metabolism - Digestion of proteins, absorption and transport of amino acids. General metabolism of amino acids. Transaminases. Deamination. Glutamate dehydrogenase. Glucogenic and ketogenic amino acids. Metabolism of branched-chain amino acids. Phenylketonuria. Urea cycle reactions. Adjustment. Extrahepatic elimination of ammonia. Glutamate and glutamine - Gluconeogenesis and its regulation.

Metabolism of pyrimidine and purine nucleotides - Biosynthesis of pyrimidines and purines. Biosynthesis of deoxyribonucleotides. Synthesis of thymidylate and tetrahydrofolate cycle. Purine catabolism. Purine nucleotide recovery pathways. Antimetabolites. Regulation of nucleotide metabolism. Formation and elimination of uric acid and related clinical aspects.

Oxidative stress and free radicals; cellular effects and their implication in pathologies.

Hormones and second messengers - Hormones and receptors. Mechanisms of action and regulation of hormonal activity. Glycemia regulation; insulin, glucagon, somatostatin and GLP-1; liver and muscle glycogen. Hypothalamic and pituitary hormones. Release hormones. GH. Prolactin. ACTH. Vasopressin. Oxytocin. Thyroid hormones. Adrenal cortical hormones. Sexual hormones. Lipid hormones; endocannabinoids prostaglandins, prostacyclins, thromboxanes. Homeostasis and regulatory role of Calcium and Phosphorus. Calcitonin. Vitamin D/calcitriol. Parathyroid hormone.

Biochemistry of nervous tissue and vision - Bioenergetics of nervous cells. Ionotropic and metabotropic receptors. Nervous signal cascade. Biosynthesis and catabolism of neurotransmitters. Biogenic amines: biological significance and metabolism. Neurotoxins. Mechanism of vision, the rhodopsin-cyclic GMP cascade.

Biochemistry of the liver- Role of the liver in gluconeogenesis. The alanine-glucose cycle. The lactate-glucose cycle. The metabolism of ethanol. Enzymatic mechanisms involved in its metabolism. Systemic effect of alcohol. Hepatic steatosis. Hepatic detoxification mechanisms. Hemoglobin catabolism and bile pigments. Bilirubin and jaundice. Direct and indirect bilirubin.

Biochemistry of kidneys – Bioenergetic. Water homeostasis. The renin-angiotensin system (RAS). Natriuretic peptides. Adrenomedulin

Biochemistry of blood and coagulation - Mode of transport of oxygen and carbon dioxide and its regulation. Plasma proteins. Erythrocyte biochemistry; Hexosomonophosphate shunt. Metabolic fate of lactate. Glutathione. Biochemistry of blood coagulation, the blood coagulation cascade. Anticoagulants and fibrinolysis. Hemoglobin. Cooperative binding of oxygen. Isohydric transport of carbon dioxide. The binding to oxygen in pathological hemoglobins. Heme biosynthesis. Biochemical bases of acid-base balance.

Biochemistry of skeletal muscle tissue and myocardium. Bioenergetics of the different fibers and use of energy sources depending on the intensity of the contraction and time. Nutrition and sporting activity, supplements and doping.

Biochemistry of connective tissue. The proteins of the extracellular matrix, collagen, elastin; fibronectin, laminin integrins; proteoglycans and glycosaminoglycans. Metabolism, role of metalloproteases. Genetic pathologies and those not related to matrix metabolism, mucopolysaccharidosis.

## **Prerequisites**

To take the Biological Chemistry and Molecular Biology exam, it is necessary to pass the Propaedeutic Sciences

## **Teaching form**

DE- 40 lessons of 2 hours carried out in presence mode

DI- 8 lessons of 2 hours carried out in presence by the teacher/tutor for the entire class or a subgroup. Discussion of the topics covered in class, additional explanations, simulation of the exam

## **Textbook and teaching resource**

1. La Biochimica di TM DEVLIN- VI ed. (2024) EDISES Università
2. Biochimica Medica- Siliprandi and Tettamanti V ed. Piccin
3. Le Basi della Biochimica- Ermine Ercikan Abali III ed. Zanichelli

## **Semester**

second year, I semester

## **Assessment method**

All students have access to a written test followed by an oral interview.

The written test consists of 20 quizzes, of which 18 single-answer and 2 a multiple-choice (CLOSED ANSWER TEST).

## **Office hours**

Reception by appointment

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## **Sustainable Development Goals**

ZERO HUNGER | GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION

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