UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Biochemistry I

2627-1-H4104D001-H4104D00102

Aims

The Biochemistry I Module aims : i) to provide the concepts necessary to understand the biological phenomena and the energetic changes connected to them, illustrating the complex chemical reactions that give rise to life. Object of study is the structure and transformation of cell components, such as proteins, carbohydrates, lipids, nucleic acids and other biomolecules. The description of the metabolism will take place both qualitatively and quantitatively. ii) to explain how organ functions can be regulated according to their particular biochemical processes, focusing on metabolic integration. iii) to explain how the regulation of metabolism occurs. iv) to illustrate the role of nutrients and balanced nutrition for maintaining the state of health.

Contents

The Biochemistry I module will illustrate the importance of life-sustaining chemical reactions. The objects of study are the structure and the metabolic pathways involved in the transformations of cell components, such as proteins, carbohydrates, lipids, nucleic acids, and other biomolecules. Moreover, the main hormones and their role in the regulation of metabolism will be described. Finally, the main components of the foods will be described in relation to a healthy diet. Clinical pearls will be provided.
The programme will also include seminars, providing insights into current developments, emerging trends, and research opportunities within the relevant field of study. Interactive activities such as group discussions, case studies, collaborative projects will foster active participation, critical thinking, and peer-to-peer learning, enhancing both academic engagement and professional development.

Detailed program

General Biochemistry and Enzymology: Introduction to the structure, properties, and biological functions of the

major biomolecules, including carbohydrates, lipids, proteins, and nucleic acids. Fundamental concepts of metabolism, metabolic pathways, and metabolic strategies. Principles of biological catalysis and enzyme kinetics. Michaelis–Menten kinetics, Vmax and Km. Factors affecting enzymatic activity, including pH, temperature, substrate concentration, and cofactors. Enzyme inhibition (reversible and irreversible). Allosteric regulation of enzymes. Isozymes and their physiological significance. Diagnostic applications of enzymes in clinical biochemistry.

Bioenergetics: High-energy compounds and energy transfer in biological systems. The citric acid cycle (Krebs cycle): reactions, regulation, and metabolic significance. Structure and function of the respiratory chain and oxidative phosphorylation. Mechanisms of ATP synthesis and cellular energy production. Inhibitors and uncouplers of oxidative phosphorylation and their physiological and pathological implications.

Carbohydrate Metabolism: Digestion, absorption, transport, and utilization of carbohydrates. Glycolysis under aerobic and anaerobic conditions and its regulation. The metabolic fate of pyruvate. Glycogen synthesis (glycogenesis) and glycogen breakdown (glycogenolysis). Gluconeogenesis and its regulation. Pentose phosphate pathway: functions, regulation, and physiological significance. Metabolism of galactose and other dietary monosaccharides. Integration of carbohydrate metabolism in physiological conditions.

Lipid Metabolism: Digestion, absorption, transport, and storage of lipids. Lipid catabolism and ?-oxidation of fatty acids. Mitochondrial fatty acid oxidation. Peroxisomal fatty acid oxidation with particular emphasis on the role of peroxisomes in the metabolism of very-long-chain fatty acids. Role of carnitine in fatty acid transport. The citric acid cycle and its integration with lipid metabolism. Lipogenesis, including fatty acid and triglyceride biosynthesis. Regulation of lipolysis and lipogenesis. Cholesterol metabolism and biosynthesis, including the formation of bile acids. Ketone body metabolism. Structure, function, and metabolism of plasma lipoproteins.

Protein and Amino Acid Metabolism: Digestion of dietary proteins, absorption, and transport of amino acids. General pathways of amino acid metabolism, including transamination, deamination, and decarboxylation reactions. Nitrogen metabolism and nitrogen balance. The urea cycle and ammonia detoxification. Metabolic fate of amino acids and their contribution to energy production and biosynthetic pathways. Gluconeogenesis and its regulation. Metabolic adaptations during fasting and prolonged nutrient deprivation.

Nucleotide Metabolism: Biosynthesis and degradation of purine and pyrimidine nucleotides. One-carbon metabolism and its role in nucleotide synthesis. Biochemical functions of folate (Vitamin B9) and cobalamin (Vitamin B12) and their clinical relevance.

Blood glucose regulation in physiological conditions

Mechanisms maintaining blood glucose homeostasis in the fasting and fed states, with particular emphasis on the coordinated actions of insulin, glucagon, and peripheral tissues. Integration of hepatic glucose production, glycogen metabolism, and glucose uptake.

Diabetes mellitus

Classification, pathophysiology, and metabolic consequences of diabetes mellitus, including alterations in glucose, lipid, and protein metabolism. Diagnostic criteria, major complications, and principles of metabolic control.

Structure, composition, role and metabolism of the different classes of plasma lipoproteins

Structural organization, biochemical composition, and physiological functions of chylomicrons, VLDL, LDL, and HDL. Lipoprotein metabolism, transport of lipids in the circulation, and their relevance to cardiovascular health and disease.

Hormonal regulation of metabolisms

Role of hormones in the integrated regulation of carbohydrate, lipid, and protein metabolism under different physiological conditions. Mechanisms of action and metabolic effects of insulin, glucagon, catecholamines, cortisol, and other key endocrine regulators.

Research Seminars and Interactive Activities: Research seminars and interactive activities tailored to the interests and academic needs of the student cohort. Interactive sessions, case studies, group discussions will promote critical thinking, scientific communication, and the application of theoretical knowledge to real-world and clinical contexts.

Prerequisites

Basic knowledge of biology and chemistry.

Teaching form

Each lecture will last either 3 or 4 hours. The course will be delivered as follows:

32 hours: In person lectures
16 hours: Online lectures

Textbook and teaching resource

Biochemistry with clinical aspects , Thomas Devlin

Biochemistry, Berg et al

Semester

1st year - II semester

Assessment method

The examination consists of a 45-minute written test composed of:

25 multiple-answer questions (1 point each);
1 short open-ended question (completion type), worth 2 points;
1 open-ended essay question, worth up to 4 points

The exam is positively evaluated with a mark of 18/30 or higher.
The questions proposed in the written exam will be constructed in such a way as to induce the student to biochemical-clinical reasoning, to understand the units of measurement, and to be able to evaluate the skills and competencies acquired according to the objectives of the course.

Office hours

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Sustainable Development Goals

GOOD HEALTH AND WELL-BEING