II year (1st-2nd semester)	Scientific Field	**BIOCHEMISTRY**	TUTOR	ECTS
	BIO/10	Biochemistry 1	Agostini Massimiliano	1
	BIO/10	Biochemistry 1	Di Venere Almerinda	3
	BIO/11	Molecular Biology	Melino Gennaro	1
CATANI M.V. **COORDINATOR**	BIO/11	Molecular Biology	Agostini Massimiliano	2
	BIO/10	Biochemistry 2	Catani Maria Valeria	4
	BIO/10	Biochemistry 2	Agostini Massimiliano	3
			TOT	14

SPECIFIC AIMS	The aim of the integrated course of Biochemistry is the knowledge, with particular reference to the human being of: 1) the structure of biological molecules and their transformations in dynamic cells; 2) the mechanisms that regulate the transmission of information at the molecular level; 3) the homeostatic mechanisms that regulate the functioning of the cell and the integration of organs and tissues; 4) the methods of investigation at the molecular level, to understand the significant biological phenomena in medicine.

PROGRAM **MOLECULAR BIOLOGY**	Biochemical aspects of the transmission of genetic information. The DNA: nucleosides, nucleotides, the primary structure. Secondary structure of DNA (B, A, Z); differences in the configuration of deoxy -ribose and other structural features. Properties of DNA in solution, hyperchromic effect, denaturation and renaturation. Hybridization. Enzymatic hydrolysis and nucleic acid chemistry. Exonuclease and endonuclease. DNA superhelix, bond number, topoisomerase . Dimensions of DNA. Localization and compaction in prokaryotes and eukaryotes. Histones, nucleosomes, chromatin (structure and function). DUPLICATION. Semiconservative DNA synthesis and bidirectionality. The duplication in prokaryotes: Mechanism of action of DNA polymerase. Correcting errors during polymerization. Role of DNA polymerase I and III. Synthesis of fast and delayed strand, Okazaki fragments. The replisome and the enzymes involved. The duplication of the bacterial chromosome. The duplication in eukaryotes: similarities with that of prokaryotes. DNA polymerase and accessory proteins. Duplication of chromosomes, their ends and the role of telomerase. Duplication errors. Damage to the DNA deamination of the bases, alkylating agents, intercalating agents, radiation. Mechanisms of DNA repair: direct repair, excision of base or nucleotide. RESTRICTION ENDONUCLEASE. Biological role and specificity. Palindrome sequences. Their use to study DNA. DNA SEQUENCE. Sanger method. RNA . Chemical structure and types . Alkaline and enzymatic hydrolysis. Mechanism of action of ribonuclease. Biosynthesis of RNA (transcription). Promoter sequences. Initiation, elongation, termination of transcription. The enzymes of the transcription in prokaryotes and eukaryotes. MATURATION of ribosomal and transport RNA in prokaryotes and eukaryotes. Enzymes involved. Exons and introns. Autosplicing. Maturation of eukaryotic mRNA: cap insertion, polyadenylation, removal of introns (splicing). GENETIC CODE. Properties and characteristics of the genetic code : codons, universality, degeneration, synonymous codons. Genetic code in mitochondria. PROTEIN SYNTHESIS. tRNA: secondary and tertiary structure, and properties. Activation of amino acids, aminoacyl synthetases. The place of initiation, elongation and termination of translation. Polyribosomes. Energy cost of protein synthesis. Post-translational modifications in proteins. REGULATION OF TRANSCRIPTION. In prokaryotes: recognition of promoters and factors. In eukaryotes: Interaction between proteins and major or minor groove of DNA. Assembly of the transcription complex and the role of transcription factors. Transcription factors to genes of class I, II and III. Hormone receptors. Role of chromatin in the regulation of transcription, histone tails and chromatin conformation, histone acetylase and deacetylase.

	MOLECULAR BIOLOGY TECHNIQUES : Southern , Northern, Western blotting , plasmids , cloning, recombinant DNA, cDNA , PCR , expression vectors , site-directed mutagenesis . Recombinant proteins. The techniques of molecular biology in the diagnosis of genetic diseases.
PROGRAM **BIOCHEMISTRY**	PROTEINS: Amino acids: structure and classification. Stereoisomerism. Acid-base properties. Peptide bond. Peptides of biological importance. Primary, secondary, tertiary, quaternary structure of proteins and bonds stabilizing structures. BLOOD PROTEINS AND ENZYMES: structure, function, diagnostic significance. Albumin. Fibrinogen and mechanisms of blood coagulation. Globulins. High and low density lipoproteins. Heme proteins. Transport and use of oxygen: hemoglobin and myoglobin; structure to function relationship, properties and allosteric cooperativity. STRUCTURAL PROTEINS: collagen. ENZYMES. Concept of catalysis. Properties of enzymes as catalysts. Classification. Kinetics of reactions enzyme. Michaelis- Menten constant. Factors that affect enzyme activity. Enzyme inhibition. Active sites and allosteric sites. Mechanism of action of enzymes: effects of proximity and orientation, acid-base catalysis, covalent catalysis. Concept of isoenzyme. Enzyme cofactors. WATER-SOLUBLE VITAMINS. Structures and roles as enzyme cofactors. CARBOHYDRATES. Mono and disaccharides of biological importance. Reserve and structural polysaccharides: starch, glycogen , cellulose; pectin; mucopolysaccharides; dextran. Polysaccharides such as components of bacterial cell walls. Polysaccharides of fundamental substances of animal tissues. Protein N- glycosylated and O- glycosylated. Carbohydrates such as carriers of information. LIPIDS. Classification and structure. Properties of fatty acids. Essential fatty acids. Prostaglandins, thromboxanes and leukotrienes. Neutral fats. Phospholipids. Glycolipids. Steroids. Lipids as structural components of the membranes. Lipids deposit as intracellular metabolic fuel. FAT-SOLUBLE VITAMINS A, D, E, K. Structures and biochemical functions. BIOENERGETICS. General principles of chemical thermodynamics. Oxidation-reduction potential. ATP; its role in energy use. Phosphorylation at the substrate level. Mitochondrion. Respiratory chain and its components. Oxidative phosphorylation. Coupling of

	oxidative phosphorylation to electron transport. Chemiosmotic mechanism. Energy balance. Uncoupling agents and inhibitors of oxidative phosphorylation. SOME METHODS OF BIOCHEMISTRY INVESTIGATION and related applications. Centrifugation. Spectroscopic techniques. Electrophoresis techniques. DIGESTION AND ABSORPTION of carbohydrates, lipids and proteins. Cycles, main metabolic pathways, and their interconnection. Glycolysis. Krebs cycle. Via pentose – phosphate. Glycogen synthesis and glycogenolysis. Gluconeogenesis. – oxidation of fatty acids. Other routes of fatty acid oxidation. Ketogenesis. Biosynthesis of fatty acids . Biosynthesis of triglycerides. Biosynthesis and catabolism of cholesterol and of its derivatives. Catabolism of proteins. General metabolism of amino acids: transamination, deamination, decarboxylation. Urea cycle. Biosynthesis and catabolism of heme. Biosynthesis and catabolism of purine and pyrimidine. METABOLISM OF OLIGOELEMENTS. OVERALL REGULATION OF METABOLISM.

TEXTBOOKS	Nelson, Cox, Lehninger Principles of Biochemistry 5th Ed Christopher K. Mathews, Kensal E. van Holde, Dean R. Appling and Spencer Anthony-Cahill, Biochemistry, 4th Ed
EXAM METHOD	Oral exam.

EXAM COMMISSION	The Coordinator, full Professors of the disciplines, Professors of similar disciplines, Specialists of the subject, compose the exam Commission of the Integrated Course.

Catani M. Valeria, President
Di Venere Almerinda
Melino Gennaro
Agostini Massimiliano

CONTACTS

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PREREQUISITES: Previous knowledge and competence in the following subjects: Chemistry and Introductory Biochemistry, Physics and Statistics, Biology and Genetics.

The specific learning outcomes of the program are coherent with the general provisions of the Bologna Process and the specific provisions of EC Directive 2005/36/EC. They lie within the European Qualifications Framework (Dublin Descriptors) as follows:

1. **Knowledge and Understanding**

- Demonstrate a comprehensive theoretical knowledge of the main molecular genetic principles and biochemical processes.
- Identify the structural components of the cell and define the main processes of cell survival and regulation, with a particular focus on DNA structure and protein synthesis.
- Understand the importance of these processes and recognize their impact for the maintenance of cell homeostasis.
- Learn the major components of the human metabolism; such as proteins, carbohydrates, lipids, vitamins and analyze their role in the metabolic processes of the human body. Integrate each process in a more systematic view.
- Understand the mechanisms of action of the new molecular biology investigation techniques and their critical utility in the clinical setting.

2. **Applying Knowledge and Understanding**

- Determine the core consequences of metabolic abnormalities.
- Apply the theoretical knowledge to the clinical setting, being able to recognize the general diagnostic aspects of metabolic abnormalities and therapeutic utilities.
- Identify and recognize the proper molecular diagnostic techniques to utilize for any particular topic of examination; giving a comprehensive description of all the available possibilities.
- Learn the practical aspects of investigative tests and their execution.
- Assess the major metabolic values and cut-offs utilized in the clinical scenario.

3. **Making Judgements**

- Recognize the most relevant outcomes of metabolic processes and emphasize the role of regulation.
- Compare the human metabolic activities to those of lower developed species and appreciate the intrinsic perfection of the human body.
- Define the most relevant factors for the evaluation of metabolic activities.

4. **Communication Skills**

- Present the topics orally in an organized and consistent manner.
- Use of proper scientific language coherent with the topic of discussion.

5. **Learning Skills**

- Identify the possible use of the acknowledged skills in the future career.
- Assess the importance of the acquired knowledge in the overall medical education process.