27108 - Biochemistry

Información del Plan Docente

Academic Year	2016/17
Academic center	100 - Facultad de Ciencias
Degree	446 - Degree in Biotechnology
ECTS	12.0
Course	2
Period	Annual
Subject Type	Compulsory
Module	---

1.Basic info

1.1.Recommendations to take this course

1.2.Activities and key dates for the course

2.Initiation

2.1.Learning outcomes that define the subject

2.2.Introduction

3.Context and competences

3.1.Goals

3.2.Context and meaning of the subject in the degree

3.3.Competences

3.4.Importance of learning outcomes

4.Evaluation

5.Activities and resources

5.1.General methodological presentation

5.2.Learning activities

5.3.Program

METABOLISM

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20. Introduction of the study of metabolism. The cycle of matter and flow of energy in the biosphere. Origin of biological energy. Organization of the metabolic pathways. Oxidation of food compounds as the source of biological energy: redox cofactors. ATP as energy exchange molecule. Coenzyme-A: thioester bond function. Metabolic regulation: general mechanisms and hormonal action. Techniques for the study of metabolism.

Carbohydrate metabolism

21. Anaerobic metabolism of carbohydrate. The utilisation of dietary carbohydrates: digestion and intestinal absorption. Glucose transporters. Glycolysis: biological significance, reactions and enzymes involved. 2,3 bisphosphoglicerate role in erythrocytes. Anaerobic fate of pyruvate: fermentation. Mitochondrial oxidation of cytosolic NADH: mitochondrial shuttles. Degradation of other monosaccharides by glycolysis. Metabolic defects in digestion and adsorption of carbohydrates.

22. Aerobic metabolism of carbohydrate. Aerobic fate of pyruvate: respiration.Cellular localization. Oxidation of pyruvate by the pyruvate dehydrogenase complex. Regulation. The citric acid cycle (Krebs cycle) **:** a)reactions and enzymes involved, b) stoichiometry and overall energy balance, c) regulation and d) the intermediates of the cycle as substrates for biosynthetic reactions and anaplerotic reactions.

23. Electron transfer and oxidative phosphorylation. The electron transport chain: multiprotein complexes and electron carriers. The generation of a proton gradient as a form of conserving the energy. Electron transport inhibitors. ATP synthesis: oxidative phosphorylation Coupling of electron transport, proton transfer and ATP synthesis: chemiosmotic theory. Uncouplers. The ATP synthase complex: structure and action mechanism.

24. Others pathways for glucose oxidation. The pentose phosphate pathway Biological role in different tissues. Anabolic and catabolic role of the pathway. Oxidative and non-oxidative phases: reaction and enzymes involved. Regulation. Interconnection between glycolysis and the pentose phosphate pathway. Metabolic defects: Glucose-6 phosphate dehydrogenase, oxidative stress, erytrocytes and malaria.

25. Gluconeogenesis. Glucose synthesis from non glucidic precursors. Common and specific enzymes in glycolysis and gluconeogenesis. Thermodynamically irreversible reactions. Origin of reducing power. Gluconeogenesis from Acetil-CoA in plants: the glyoxylate cycle. Disaccharides synthesis: sucrose and lactose. a-lactoalbumin in lactose synthesis.

26. Glycogen metabolism. The role of glycogen in animals. Glycogen degradation and synthesis: reactions and enzymes involved. Glycogenin in glycogen synthesis. Futile or substrate cycles. Diseases due to defects in the glycogen metabolism.

27. Regulation of carbohydrate metabolism. Glycolysis regulation : hormonal and allosteric mechanisms. Coordinated regulation of glycolysis and **gluconeogenesis** : Fructose 2,6 bisphosphate and Phosphofructokinase II. **Cell**

energy level and oxidative phosphorylation regulation. Glycogen metabolism regulation : the role of metabolic cascades, glycogen phosphorylase kinase, glycogen phosphorylase and glycogen synthase. A) muscle and liver differences, B) hormonal and allosteric regulation: insulin, glucagon, adrenaline and blood glucose, C) role of the phospho protein phosphatase-1 (PP1) and others regulatory proteins.

LIPID metabolism

28. Origin and transport of lipids in animals. Digestion and absorption of dietary fats in the small intestine. Mobilization of stored triacylglycerols: hormones involved and role of perilipin protein and adipocyte lipases. Lypolisis inhibition: insuline action and retroinhibition mechanisms. Transport of lipids in animals: albumin and plasmatic lipoproteins.

29. Fatty acids catabolism. Activation and transport of fatty acids into the mitochondria. Carnitine role. b-oxidation mitochondrial and perixosomal of fatty acids. Energy balance. Fatty acid degradation functions: thermogenesis and uncouple proteins (UCPs). Oxidation of fatty acids with an odd number of carbons: fate of propionate. Oxidation of unsaturated fatty acids: additional reactions. w- and a-oxidation of fatty acids. **Ketonic bodies** : synthesis and degradation. The use of ketone bodies as a source of energy.

30. Biosynthesis of fatty acids. Similarities and differences between the biosynthetic and degradative pathways. **Biosynthesis of saturated fatty acids** : origin of carbon and reducing power (NADPH). Acetyl-Co and bicarbonate as precursors of fatty acid synthesis: the Acetil-CoA carboxilase and the formation of malonyl-CoA. Fatty acid synthase complex. Origin of cytosolic NADPH and Acetyl-CoA. **Biosynthesis of unsaturated fatty acid** : desaturation and elongation of fatty acids. Peroxisomes role in polyunsaturated fatty acid synthesis. **Fatty acid metabolism regulation** : a) role of hormones insulin, glucagon and adrenaline, b) transcription factors: CHREBP, SREBP and PPARs.

31. Biosynthesis of complex lipids. Biosynthesis of triacylglycerols: origin of glycerol and main reactions. Triacylglicerols cycle: regulation. Biosynthesis of phosphoacylglycerols and sphingolipids. Icosanoids: therapeutics effects and main reactions of synthesis. Ciclooxygenases (COX).

32. Biosynthesis of cholesterol. Acetil-CoA as cholesterol precursor.General steps in cholesterol biosynthesis **.** Transport and cellular internalization of cholesterol: action mechanism of transport by lipoproteins. Regulation of cholesterol synthesis: Hidroxymethylglutaryl-CoA reductase and LDL receptors: a) covalent modification and b) transcription factors: SREBP and the regulatory proteins SCAP and INSIG. Cholesterol as precursor of active biological molecules.

nitrogen compounds metabolism

33. General features of the nitrogen metabolism: metabolic value, new reactions and coenzymes, interconnect

pathways and regulation.The incorporation of ammonia into carbon skeletons: glutamate dehydrogenase, glutamate synthase and glutamine synthetase.Regulation of nitrogen metabolism: glutamine synthetase regulation. **Degradation of the proteins and amino acids I.** Digestion of dietary proteins. Continuous replacement of proteins in living organisms. General reactions: nitrogen elimination and carbon skeleton degradation.

34. Amino acid degradation II . Transamination and oxidative degradation. Main coenzymes: piridoxal phosphate. Special role of glutamate, glutamine and alanine amino acids in nitrogen transfers. Glucose-alanine cycle. Glutamine synthetase and glutaminase in muscle and liver. **Urea cycle:** reactions, enzymes involved, regulation and genetic defects. Relation with the citric acid cycle. Role of the liver glutamine synthetase in the blood pH regulation.

35. Amino acid degradation III. Metabolic degradation of carbon skeletons from amino acids. Glycogenic and ketogenic amino acids. Main reactions: oxidations and carbon transfers. **Main coenzymes: tetrahydrobiopterin, tetrahydrofolate (folic acid vitamin) and S-adenosylmethionine. Activated-methyl cycle.** Genetic disorders in the amino acids metabolism.

36. Biosynthesis of amino acids and related compounds. Precursors and general features of the synthesis pathways (carbon and nitrogen transfers). General principles of the regulation of the synthesis of amino acids. Amino acids as precursors to other important molecules.

37. Nucleotide metabolism. Biosynthesis of nucleotides : the *de novo* and the salvage pathways. **De novo pathway** of the purine and pyrimidine ribonucleotides: precursors, main steps and regulation. Function and synthesis of 5-phosphoribosyl 1-pyrophosphate PRPP). Deoxyribonucleotide synthesis: ribonucleotide reductase, substrata and mechanism. Activity and substrate specificity regulation of ribonucleotide reductase. Synthesis of thymidylate: thymidylate synthase and dihydrofolatereductase. Inhibitors of the nucleotides synthesis: fluorouracil and methotrexate. **Salvage pathways** : a) acid nucleic degradation, b) PRPP-transferase and specific kinases. Nucleotide catabolism: urea, uric acid production. Genetic disorders in the nucleotide metabolism.

38. Integration of metabolism . A) Reciprocal relationships between different organs in animals. The main metabolic pathways in the different organs: liver, adipocyte, brain, muscle and kidney. B) Main mechanisms of hormonal regulation. C) Metabolic adaptations to different physiological and pathological situations: fasting, prolonged exercise, obesity and diabetes.

5.4.Planning and scheduling

5.5.Bibliography and recomended resources

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BB	Lehninger, A.. Principles of Biochemistry. 6th W. H. Freeman & Company. 2013
BB	McKee, Trudy. Bioquímica : las bases moleculares de la vida / Trudy McKee, James R. McKee ; traducción, Martha Elena Araiza Martínez, Anahí Hurtado Chong . - 5ª ed. Madrid [etc.] : McGraw-Hill Interamericana, cop. 2014
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BC	Biochemistry / Laurence A. Moran, J. David Rawn... [et al] . - 2nd ed. Englewood Cliffs, New Jersey : Prentice Hall, cop.1994
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