INTERAMERICAN UNIVERSITY OF PUERTO RICO
_____ CAMPUS
DEPARTMENT OF _____

SYLLABUS

I. GENERAL INFORMATION

Course Title:	Biochemistry
Código y Número:	CHEM 4220
Credits:	4
Pre-Requirements:	CHEM 3320 y CHEM 2222

1. Course Description:

Chemical reactions that occur in living systems, using modern techniques of analysis of carbohydrates, lipids, proteins, nucleic acids, hormones and minerals. It requires 45 hours of conference and 45 hours of laboratory.

1. Objectives

A. Terminals

1. Familiarize students with the constituent molecules of living matter and with the chemical reactions necessary to maintain homeostasis in biological systems.

2. Raise awareness among students about the direct applications of biochemical knowledge in society.

3. Familiarize students with the analysis of various biological compounds through experiments.

4. Apply ethical principles in situations relevant to the field of Biochemistry.

B. Capacitantes

Amino Acids

1. Classification of amino acids

1. Recognize L and D amino acids and their chemical structures. Establish the ionization state at a given pH.
2. Classify amino acids according to:

a. the side chain polarity
b. polar side chains without ionizable groups
c. polar side chains but with ionizable groups

d. aromatic and aliphatic side chains

2. General properties of the twenty common amino acids

    1. Recognize functional groups in amino acids that may behave as weak acids and bases, identify the value of (pK_a) for these groups.
    2. Construct titration curves for amino acids and identify the equilibrium species present in the different regions of the titration curve. Identify buffer regions and pKa's.
    3. Define the isoelectric point of an amino acid (pI), and use the values of the acidity constants to calculate its numerical value. Set the structure of the zwitterion.

3. Essential amino acids

    1. Identify the essential amino acids.

    2. Establish the biological importance of the catechol family

Proteins

1. Recognize and define the groups and bonds present in proteins, such as peptide bonds, hydrogen bonds, sulfur bridges and other non-covalent interactions.
2. Describe the primary, secondary, tertiary and quaternary structure in proteins.
3. Describe in detail the secondary structures: α helix and β sheets and identify the amino acids that prefer one or another conformation using examples of fibrous and globular proteins. Describe super secondary and quaternary structures.
4. Describe the types of intermolecular forces that stabilize the tertiary structure in proteins and diseases related to their unfolding (conformational diseases).
5. Describe the process of denaturing a protein and the chemical and physical factors that may cause it.
6. Describe the most important chemical and physical methods used for protein purification and sequencing.
7. Describe the four most commonly used methods to obtain the three-dimensional structure of proteins.

Hemoglobina y Mioglobina

1. Describe the oxygen transport in vertebrates qualitatively and mathematically using the aturation fraction and $P_{50.}$
2. Describe the structural and biological properties of hemoglobin and myoglobin.
3. Describe allosterism and its importance in hemoglobin.
4. Interpret the saturation curves of these proteins for different organisms and the relationship of P_{50} with oxygen affinity.

5. Describe the Bohr effect and allosteric effectors on hemoglobin.
6. Recognize the most common diseases associated with hemoglobin.

Enzymes

1. Enzymes as catalysts

    1. Recognize and identify all the factors by which an enzyme accelerates a chemical reaction.
    2. Recognize the experimental basis for proposing the existence of an enzyme-substrate (ES) complex.
    1. Describe in detail the Michaelis-Menten mechanism and its law of speed.

2. Cofactors and coenzymes

    1. Describe the concepts of cofactors and coenzymes and give examples of these.
    2. Recognize water-soluble vitamins as components of coenzymes.

3. Enzyme kinetics

    1. Describe in a general way the following concepts applied to reaction rate curves as a function of substrate:

        a. Reaction rate
        b. Rate constant
        c. Reaction order

    2. Describe the equilibrium that characterizes the interaction of an enzyme with its substrate.
    3. Recognize the kinetic equation that describes this equilibrium (Michaelis-Menten equation).
    4. Define and interpret the importance of the parameters:

        K_M
        $V_{máx}$
        k_{cat}
        k_{cat}/K_M

    5. Using graphical methods, distinguish between the types of inhibitors: irreversible, competitive, competitive, mixed and non-competitive (Michaelis-Menten and Lineweaver-Burk graphs, among others).

4. Mechanism and regulation of enzymes

1. Describe the proposed chemical mechanisms for the hydrolysis of a peptide or protein by the serine protease family and the aspartic protease family
2. Describe the chemical mechanism of carbonic anhydrase
4. Describe the chemical mechanism of lysozyme.
5. Identify the regulatory mechanisms of enzymatic activity.

Lípidos

1. Classify the different classes of lipids based on molecular structure.
2. Recognize the main biological characteristics of different lipids.
3. Describe the function of lipoproteins in humans.
4. Describe the fluid mosaic model.
5. Identify the structural characteristics of membrane proteins and their interaction with the phospholipid bilayer.

Carbohidratos

1. Classify the different types of carbohydrates based on their functional groups.
2. Recognize the structure, nomenclature and conformation of the main mono-, di- and polysaccharides.

Nucleótidos

1. Classify nucleotides and nucleosides based on their chemical structures.

Metabolism

1. Carbohydrates.

    a. Recognize and integrate the different glycolysis reactions and enzymes.

    b. Recognize the metabolic pathways of glycolysis.

    c. Integrate in a general way the reactions of the Krebs cycle.

    d. Identify reactions involved in oxidative phosphorylation and ATP synthesis sites.

    e. Integrate the different reactions of Glucogenesis, Glycogenolysis and Gluconeogenesis.

2. Lipids

a. Integrate the reactions of:

Activation of a fatty acid, transport of activated fatty acid to the mitochondrial matrix, β-oxidation

Genetic information

1. Copy the information

   a. Recognize the replication of deoxyribonucleic acid (DNA).
   b. Describe the reaction mechanism of DNA polymerase III and DNA ligase.
   c. Recognize the different stages involved in the preparation of complementary DNA (cDN).

2. Transfer of information
   a. Recognize DNA as a template.
   b. Recognize the characteristics of ribonucleic acid (RNA) polymerase.
   c. Describe the transcription mechanism.
   d. Recognize different types of RNA and their structural characteristics.

3. Decoding of information

   a. Recognize the characteristics of the genetic code.
   b. Recognize translation mechanisms.

1. Recombinant DNA Technology (rDNA)

   a. Recognize the vectors important for DNA cloning.
   b. Recognize the characteristics of enzymes used to repair rDNA
   c. Recognize the stages involved in the expression of cloned genes.
   d. Describe the CRISP/CAS9 technique and its application,

GRADUATE PROFILE COMPETENCES ADDRESSED IN THIS COURSE:

1. Use the three-dimensional structure of biomolecules to explain their chemical and biological function.

2. Analyze and interpret experimental data and scientific literature related to the course topics.

3. Awareness of ethical and cultural values in the practice of biochemistry.

Experiments

All students will perform the following experiments and **each** student will submit an ***individual*** lab report:

1. Determination of the concentration of a protein by the Biuret technique.

2. Separation of the components – amino acid, protein and polysaccharide – in a mixture by column chromatography (CM-Sephadex, G-50).

3. Identification of an amino acid by determining the pK_a, pI and its molar mass by titration.

4. Denaturation curve of a protein using fluorescence.

5. Wheat Germ Acid Phosphatase Kinetics (has 5 parts)

    1. Preparation of the calibration curve for p-nitrophenol, an indicator of hydrolysis of p-nitrophenyl phosphate by wheat germ acid phosphatase.
    2. Determination of the optimal pH for the enzyme.
    3. Determination of the dilution of the enzyme that continues to hydrolyze the substrate linearly for 30 minutes.
    4. Determination of the Michaelis-Menten constant ($K_{M),}V_{max}$ and k_{cat}
    5. Determination of the type of inhibition and the inhibition constant (K_i) for inorganic phosphate.

The lab manual has been prepared by Professor Colom and is available on Blackboard.

6. Computational Biochemical Experiment (bioinformatics; docking)

IF YOU ARE ABSENT FROM A LABORATORY, YOU CANNOT SUBMIT THE REPORT OF THAT EXPERIMENT.

EVALUATION:

1. The evaluation of the course consists of two parts:

    - Lecture (70%) and Laboratory (30%). the following table contains the weight of each component in the Lecture component :

Evaluation Criteria	Points	Weight (%)
Partial Exam 1	100	17.5
Partial Exam 2	100	17.5
Partial Exam 3	100	17.5
Final examination	100	17.5
Total Points	400	70%

IN THIS COURSE THERE ARE NO "SPECIAL ASSIGNMENTS" TO RAISE NOTE.

- Laboratory Evaluation:

	Points	Weight
5 lab reports	500	15%
Participation	100	5%
Final Exam Grade	100	10 %
Total Points	700	30%

IF YOU MISS A LABORATORY, YOU CANNOT SUBMIT THE REPORT OF THAT EXPERIMENT.

BY RULES OF THE DEPARTMENT OF NATURAL SCIENCES, IF YOU ARE ABSENT FROM THREE LABORATORIES OR MORE YOU WILL RECEIVE "F" IN THE COURSE.

Scale used in CHEM 4220

The final grade of the course is calculated by adding the percent obtained in the conference (of 70%) and that obtained in the laboratory (of 30%).

100-85 A 84 - 75 B 74 - 65 C 64 – 55 D 54 - 0 F

Special Notes

Any student who requires auxiliary services or special assistance must request them at the beginning of the course or as soon as he acquires knowledge of the services he will need, through registration in the Office of the Professional Counselor, Mr. José Rodríguez of the University Orientation Program.

Plagiarism and fraud:

It is important to be clear that the different forms of plagiarism (the use of someone else's ideas or words without due recognition) is an academic infraction with very serious consequences. See the *General Student Regulations of the Inter-American University 2004,* from page 60 onwards for examples of the types of plagiarism and the sanctions that apply. In this course this type of practice will be penalized.

Use of electronic devices:

Cell phones and any other electronic devices that could disrupt teaching and learning processes will be deactivated. Particular situations will be addressed, as appropriate. The handling of electronic devices that allow access, storage or sending data during evaluations or exams is prohibited.

Resources

1. ***TEXT:*** *Fundamentals of Biochemistry*: *Life at a Molecular Level* Donald Voet, Charlotte W. Prattt and Judith G. Voet, 5th Edition, John Wiley: 2016

2. *Lehninger Principles of Biochemistry* 7th Edition, David L. Nelson and Michael M. Cox, W.H. Freeman: 2017

3. *Manual de Laboratorio: Procedimientos de Experimentos y Guías de Informes para Bioquímica* (CHEM 4220), A.Colom. (Available on Blackboard)

Additional References (any of the following texts is also recommended as a reference book in its most recent editions):

1. *Essential Biochemistry*, 3rd Edition, Pratt y Cornely (2013)

2. *Biochemistry: Concepts and Connections*, Dean R. Appling, Spencer J. Anthony-Cahill and Christopher K. Mathews, Pearson: 2016.

3. *Principles of Biochemistry*, Horton et al., 3rd Edition, Prentice Hall: 2002

4. *Modern Experimental Biochemistry*, Boyer, Benjamin Cummings: 2000.

5. *Biochemistry*, 5th Edition, Berg, J.M. et al., W.H. Freeman and Company: New York, 2002.

Some websites:

1. www.ncbi.nih.gov (Página de Internet del Gobierno Federal)
2. www.rcsb/org (The Protein Data Bank "PDB")
3. http://pir.georgetown.edu (Protein Information Resource "PIR")
4. http://scop.mrc-lmb.cam.ac.uk/scop (Structural Classification of Proteins "SCOPE")
5. http://expasy.org/prosite (Prosite)

6. Khan Academy

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