SAGRADO
Universidad del Sagrado Corazón

SCHOOL OF HEALTH AND SCIENCES

SYLLABUS

TITLE: Biochemistry

CODE: QUI 403

PREREQUISITE: QUI 302

CORREQUISITES: QUI 403L

CREDITS: 4 credits | 45 contact hours | 45 lab hours | 1 term

DESCRIPTION

This course discusses the fundamental principles of Biochemistry and the relation of biomolecules to metabolic processes. Emphasis is placed on protein structures and the regulation of enzymatic activity during various processes of cellular metabolism and molecular genetics. Determination of protein and nucleic acid structures.

JUSTIFICATION

Biochemistry is a very extensive field, multidisciplinary in nature, as it includes chemical, physical, and biological principles. General knowledge in biochemistry will enable students to grasp the basis of life chemistry and cellular metabolism. Biochemistry is part of the academic training of those students who are going to pursue graduate or professional studies in areas such as Physiology, Molecular Biology, Medical Technology, Medicine, Dentistry, Veterinary Medicine, and other biomedical or clinical applications.

COMPETENCES

The course develops the following competences in students:

- **Critical questioning**
- **Research and exploration**

OBJECTIVES

After completion of the course, students will be able to:

1. Identify functional groups in important organic molecules of biological systems.

2. Explain the properties of the water molecule and its importance in biochemical processes.
3. Describe the structure, function, and some physical properties of carbohydrates, lipids, proteins, and nucleic acids.
4. Describe the structures and properties of amino acids.
5. Explain the structural organization of proteins and how these structural levels are associated with their function.
6. Explain the characteristic, function, and regulation of enzymes.
7. Describe the structure of lipids and their importance in cell membranes.
8. Describe what metabolism is and various characteristics of these processes.
9. Explain the basic metabolic processes that occur in living systems.
10. Describe the structure and function of nucleic acids.
11. Develop skills in the handling and use of instruments, equipment, and techniques used in biochemical research.

CONTENTS

I. Water, Acid-Base Chemistry, Organic Acids, and Buffer Systems
   A. Properties of water
      1. Structure and polarity of the water molecule
      2. Intermolecular forces in water, polar covalent bonds, and hydrogen bonds
      3. Solubility of ionic compounds in water, ion-dipole interaction
      4. Water-soluble and fat-soluble organic compounds
   B. Water ionization and acid-base chemistry
      1. Water ionization (H_3O+, OH-)
      2. Kw, pH, pOH, pH scale
      3. Bronsted-Lowry definition (inorganic acids and bases)
      4. Organic acids (Ka and pKa)
      5. Henderson-Hasselbalch equation and buffers
      6. Computation of pH, $[H^+]$, pOH, Ka, $[A^-]$ and pKa
II. Organic Molecules, Functional Groups, Organic Molecules of Life
   A. Structure and function of organic molecules of life
      1. Carbohydrates
         a. General structure of carbohydrates (aldose and ketose)

b. Structure and function of monosaccharides, disaccharides, and polysaccharides
c. Saccharide reactions associated with metabolism

2. Lipids
    a. General characteristics of lipids
    b. Saturated and unsaturated fatty acids
    c. Structure and function of triglycerides
    d. triglycerides with saturated and unsaturated fatty acids (oil, lard, fats with trans bonds)
    e. Structure of phospholipids
    f. Cholesterol and steroids
    g. Eicosanoids
    h. Transduction-associated lipid reactions
3. Proteins
    a. Composition of proteins
    b. Function of proteins
4. Nucleic acids
    a. Composition of nucleic acids
    b. Function of nucleic acids

III. Structure and function of amino acids and proteins

A. Amino acids
    1. Structure
    2. Optical activity
    3. Zwitterionic forms
    4. Isoelectric point
    5. Strong base titration curves
    6. Polarity of amino acids depending on their side chain

B. Proteins
    1. Primary structure (see SN reaction for peptide bond formation)
    2. Secondary structure (α and β protein structures, gyrations, and random structure)
    3. Tertiary structure
        a. Intramolecular interactions between amino acids

b. Side chains
c. Disulfide bonds
d. Water and other solvents

4. Quaternary structures and collagen
5. Structure of antibodies
    a. Antibody conjugation for immunotoxin formation
    b. Conjugation chemistry to form an immunotoxin
    c. Application in medicine
6. Hemoglobin structure and function
    a. Structure of myoglobin vs hemoglobin
    b. Saturation curves of myoglobin vs hemoglobin
    c. Variable hemoglobin affinity (cooperative bonding, effect of pH, and temperature on affinity)
7. Structure and function of the muscle sarcomere
    a. Muscle cell structure
    b. Structure of sarcomere (myosin, actin, tropomyosin, and troponin)
    c. Enzymatic and mechanical activity of myosin

IV. Kinetics and Regulation of Enzymes

A. Characteristics and classification of enzymes (brief classification)
B. Structure of enzymes
    1. 3D structure of the active site
    2. Catalytic and fixation groups and their chemistry
    3. Chymotrypsin
C. Relationship between structure and enzyme activity
D. Michaelis-Menten equation and factors affecting velocity
    1. [E]
    2. [S]
    3. pH
    4. T
    5. Modifiers (inhibitors, activators, etc.)
E. Experimental determination of the rate of the enzymatic reaction
    1. Determination of kinetic parameters (Vmax, kcat and Km)

2. Michaelis-Menten and Lineweaver-Burk models

F. Mechanisms of enzymatic regulation
    1. Enzyme and substrate concentration
    2. Effect of temperature and pH on enzyme activity
    3. Covalent modifications (phosphorylation and zymogens)
    4. Inhibition
        a. Types of inhibitors: reversible (subclassified) and irreversible
        b. Allosteric inhibition

V. Metabolism Basics

A. Basic characteristics of metabolic pathways
    1. Mechanisms of metabolic regulation
    2. ATP, creatine, and NADH

B. Carbohydrates and cellular respiration

C. Glycolysis
    1. Glucose transporters
    2. Types of hexokinases
    3. Glycolysis and oxidative phosphorylation pathway
    4. Aerobic respiration vs anaerobic respiration
    5. Glycolysis regulation points
    6. Congenital metabolic conditions

D. Citric acid cycle
    1. Pathway
    2. Points of regulation

E. Electron transport chain
    1. Role of NADH and FADH
    2. Electron transport chain and proton gradient
    3. ATP synthase and ATP production
    4. Oxygen as an oxidizing agent and metabolic water

F. Gluconeogenesis
    1. Metabolic pathway of gluconeogenesis
    2. Gluconeogenesis points of regulation

G. Fatty acid metabolism
    1. β oxidation of fatty acids

LAB EXPERIENCES

A. Biosafety standards and handling of biological samples, material, equipment, and procedures
B. Water and solutions
C. pH & buffers
D. Amino acids and proteins
E. Non-specific regulation of enzyme activity
F. Carbohydrate metabolism
G. Lipid metabolism
H. Metabolism of nitrogenous compounds
I. Extraction of DNA from plant cells

METHODOLOGY

The following strategies from the active learning methodology are recommended:

- Lectures & class discussion
- Use of visual resources including molecular modeling
- Laboratory activities where the student answers questions through the use of different activities and experimental techniques
- Collaborative work
- Solving a problem posed
- Web-supported education
- Literature research

EVALUATION

Partial assignments (tests)	60%
Weekly quizzes	10%
Final project or exam	10%
Immersion experience (lab)	20%
Total	**100%**

LEARNING ASSESSMENT

The institutional assessment rubric is applied to the course's core activity.

BIBLIOGRAPHY

TEXTBOOK

Ferrier, D. (2017). *Lippincott's Illustrated Reviews: Biochemistry* (7th ed.), LWW.

REFERENCES

Campbell, M.K. (2018). *Biochemistry*. Cengage Learning.

Horton, R. A., Moran, L. A., Scrimgeour, G., Perry, M., & Rawn, D. (2012). *Principles of Biochemistry* (5th ed.). Pearson Prentice Hall, Inc.

Lehninger, A., Nelson, D. L., & Cox, M. M. (2017). *Principles of Biochemistry* (7th ed.) W. Freeman and Company.

Miesfeld, R. L. (2017). *Biochemistry*. WW Norton.

Voet, D., Voe, J. G. (2015). *Fundamentals of Biochemistry: Life at the Molecular Level* (4th ed.). Wiley.

For more information resources related to the course's topics, access the library's webpage http://biblioteca.sagrado.edu/

REASONABLE ACCOMMODATION

For detailed information on the process and required documentation you should visit the corresponding office. To ensure equal conditions, in compliance with the ADA Act (1990) and the Rehabilitation Act (1973), as amended, any student in need of reasonable accommodation or special assistance must complete the process established by the Vice Presidency for Academic Affairs.

ACADEMIC INTEGRITY

This policy applies to all students enrolled at Universidad del Sagrado Corazón to take courses with or without academic credit. A lack of academic integrity is any act or omission that does not demonstrate the honesty, transparency, and responsibility that should characterize all academic activity. Any student who fails to comply with the Honesty, Fraud, and Plagiarism Policy is exposed to the following sanctions: receive a grade of zero in the evaluation and / or repetition of the assignment in the seminar, a

grade of F (*) in the seminar, suspension, or expulsion as established in the Academic Integrity Policy effective in November 2022.