SAGRADO
Universidad del Sagrado Corazón

SCHOOL OF HEALTH AND SCIENCES

SYLLABUS

TITLE:	Cellular and Molecular Biology
CODE:	BIO 429
PREREQUISITE	BIO 112 / BIO 112L
CORREQUISITE	BIO 429L
CREDITS:	4 credits | 45 contact hours | 45 lab hours | 1 term

DESCRIPTION

This course studies the structures and functions of cells at the molecular level. It emphasizes on chromatin structures and functions, membrane systems, cytoskeleton, cellular organelles, and extracellular materials. Some of the events associated with these cellular components are gene regulation, biosynthesis, transport mechanisms, energy conversions, morphological changes, signaling and communication mechanisms between cells, and cell cycle regulation.

JUSTIFICATION

Biology at the cellular and molecular levels is the basis for understanding many biological events or problems. The knowledge and technologies derived from this field have profoundly affected all fields of Biology. Research in the areas of Genetics, Developmental Biology, Immunology, Microbiology, Plant, Animal, and Human Physiology, Biochemistry and Ecology would be incomplete without the contributions of the field of Cellular and Molecular Biology. In addition, this field of Biology, through biotechnology, is contributing greatly to the solution of various social problems related to health and economic productivity. For these reasons, in many universities, Cellular and Molecular Biology has become a required course for undergraduate students in Biology.

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. Discuss and explain various mechanisms at the molecular level of the organization of genetic information and its use for biosynthesis.
2. Discuss and explain membrane structure and physiology, biological membrane systems, and vesicle trafficking.
3. Describe and discuss the cellular mechanisms of energy conversions.
4. Analyze various signal mechanisms between cells.
5. Describe and explain the structure and function of the cytoskeleton and how it integrates with other intracellular and extracellular systems or processes.
6. Discuss the role of the extracellular matrix and cell adhesions in morphology, morphogenetic movements, and cell interactions.
7. Discuss the cell cycle and its regulatory mechanisms.
8. Perform laboratory exercises to develop skills in techniques used in research at the cellular and molecular levels.

CONTENTS

I. Cell Theory: Prokaryotic and Eukaryotic Cells
   A. Chemical basis of Biology
      1. Basic biological molecules and macromolecules
         a. Structures and functions
   B. General description of prokaryotic and eukaryotic cells
      1. Structures and functions

II. Nuclear Structure and Function
   A. Structure of DNA and chromatin
   B. Mechanisms of DNA synthesis and repair
   C. Mechanisms of transcription and gene regulation
      1. Prokaryotic cell
      2. Eukaryotic cell

a. Levels of genetic expression and regulation
b. Transcriptional and posttranscriptional regulation
c. Structural domains and motifs
d. Translational and post-translational control

D. Mechanisms of protein synthesis

III. Structure and Physiology of Membranes

A. Plasma membrane

1. Structure and biophysical characteristics of the plasma membrane
2. Passive transport
3. Active transport
    a. Phosphorylate transport: Sodium/Potassium, Proton, Hydrogen/Potassium/ATPase
    b. Other pumps: Type V, light-propelled proton pumps
    c. ATP-binding cassette (ABC) transporter

B. Endocrine, paracrine, and synaptic signal mechanisms

1. Physiology of neurons (membrane potentials, action potential, impulse conduction)
2. Mechanisms of signal transduction across plasma membranes
    a. Protein channel-bound receptors
    b. G-protein-complex-linked receptors
    c. Receptors with catalytic units
    d. AMP_c, Ca^{++} and phosphoinositides

IV. Energy

A. Mitochondria

1. Structure
2. Location
3. Krebs cycle
4. Glyoxylate cycle
5. Electron transport chain
6. Oxidative phosphorylation

B. Chloroplast

1. Structure
2. Photosystems

3. Photophosphorylation
4. Calvin-Benson Cycle
5. Hatch-Slack Cycle
6. Photorespiration
7. CAM Metabolism

V. Internal Membrane System
   A. Intracellular membranes
      1. Endoplasmic reticulum
      2. Golgi complex
   B. Vesicle transport
   C. Lysosomes
   D. Process of endocytosis and exocytosis

VI. VI. Cellular Cytoskeleton
   A. Structure
      1. Microtubules
         a. Protein constituents
         b. Assembly
         c. Microtubule-Associated Proteins (MAPs)
         d. Vesicle transport
      2. Microfilaments
         a. Skeletal muscles
         b. Muscle contraction
         c. Amoeboid movement
         d. Cytoplasmic current
         e. Cytokinesis
      3. Intermediate filaments

VII. Cell reproduction
   A. Cell cycle
      1. Phases
      2. Cell cycle control
   B. Mitosis and cytokinesis
   C. Meiosis

VIII. Extracellular Matrix

A. Role of the cell wall
B. Role of the extracellular matrix in animal tissues
C. Proteins: integrins and collagen
D. Cell junctions
    1. Adherent
    2. Occluding
    3. Open
    4. Plasmodesmata

LABORATORY EXERCISES

A. Discussion on techniques and instruments used in Cellular and Molecular Biology
B. Amplification of genes by the Polymerase Chain Reaction (PCR) technique
C. Using spectrophotometry to determine protein concentrations
D. Protein separation with electrophoresis (SDS-PAGE) and determination of molecular weights
E. Separation of macromolecules using column chromatography
F. Cutting of lambda bacteriophage DNA with restriction enzymes and separation and analysis of fragments by horizontal agarose electrophoresis
G. Preparation of primary cell cultures
H. Fluorescent histochemistry against microfilaments and microtubules

METHODOLOGY

The following strategies from the active learning methodology are recommended:

- Lectures
- Class discussion
- Study of online material
- Critical analysis of peer-reviewed articles
- Laboratory practice
- Teamwork and cooperative learning
- Presentations
- Use of the computer for online study activities and virtual references

EVALUATION

Partial assignments	30%
Oral presentations	10%
Compositions	20%
Final project or exam	15%
Immersion experience	25%
Total	**100%**

LEARNING ASSESSMENT

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

BIBLIOGRAPHY

TEXTBOOK

Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., Walter, P., & Wilson, J. (2022). *Molecular biology of the cell* (7th ed.) W.W. Norton & Company ISBN-10: 0393884821

REFERENCES

Alberts, B., Johnson, A. J., Lewis, J., Morgan, D., Raff, M. C., Roberts, K., & Walter, P. (2006). *Molecular Biology of The Cell* (5th ed.). Garland Science.

Rybicki, E. (2005). *A Manual of Online Molecular Biology Techniques*. University of Cape Town. http://hdl.handle.net/11427/7458

ELECTRONIC REFERENCES

The Biology Project: Cell Biology.

http://www.biology.arizona.edu/CELL_BIO/cell_bio.html

Biology Tutorials. http://www.biology-online.org/tutorials/1_cell_biology.htm

Cell Biology Web Pages Menu. http://cellbio.utmb.edu/cellbio/

Interactive Biology. http://serendip.brynmawr.edu/sci_edu/biosites.html

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 Student Affairs.

- Students participating in the Student Support Program (PAE, in Spanish) shall request their reasonable accommodation in PAE's offices.
- Students who do not participate in PAE shall request their reasonable accommodation at the Integral Wellness Center (*Centro de Bienestar Integral*, in Spanish).

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.

RESEARCH COURSES

This course may require students to practice tasks related to the research process, such as taking informed consent or assent, administering instruments, conducting interviews, observations, or focus groups, among others. These assignments are part of an academic exercise and the information collected will not be used to share with third parties or disclose it in settings other than the classroom with the professor teaching the course. Every student, as well as their professor, who will interact with human subjects as part of their research practice must be certified in ethics with human subjects in research by the Collaborative Institutional Training Initiative (CITI Program).