

SCHOOL OF HEALTH AND SCIENCES

SYLLABUS

TITLE:	Developmental Biology
CODE:	BIO 323
PREREQUISITE:	BIO 112
CO-REQUISITE:	BIO 323L
CREDITS:	4 credits 45 contact hours 45 lab hours 1 term

DESCRIPTION

Developmental Biology has great scientific and social importance, making it a required course of the Biology Program. The course includes the theory and practice of organism development by analyzing the basic developmental processes at the molecular, cellular, and tissue levels. Cell interactions, differential gene activation, morphogenetic movements and tissue induction are analyzed. Experimental techniques are used through laboratory exercises to study the development of animals. Ethical and social problems associated with development research and its applications are discussed.

JUSTIFICATION

Historically, man has questioned how it is possible for a multicellular organism to emerge, possessing cells with functions as diverse and complex as transmitting nerve impulses or producing antibodies, from a single cell. The integration of different branches of Biology such as Cytology, Molecular Genetics and Embryology has made it possible to elucidate events and mechanisms involved in the establishment of body plans and the formation of the tissues of an organism from a zygote. Understanding processes such as aging and cancer depends on knowledge that continually emerges from research conducted in the area of Developmental Biology. Tissue engineering, in vitro fertilization, and cloning, which have generated widespread discussion due to their moral and ethical aspects, stem from studies in this area. Developmental Biology is an essential science that provides basic and necessary concepts for the training of professionals in the field of biology.

COMPETENCES

The course develops the following competences in students:

- **Critical questioning**
- **Research and exploration**
- **Ethical sense and social justice**

OBJECTIVES

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

1. Analyze the basic processes of development based on the findings of research in this field.
2. Interpret the results and scientific and social implications of studies on tissue formation for transplants, in vitro fertilization, cancer, regeneration, cloning, and aging.
3. Analyze and interpret developmental models using mathematical reasoning.
4. Evaluate different models of the mechanisms of differential transcription and gene regulation to suggest solutions to the problem of the origin of cell diversity in multicellular organisms.
5. Recognize the dynamic nature of technology to access and use information in ways that support communication among the scientific community.
6. Analyze ethical and social issues associated with development research.
7. Analyze research on morphogenetic determinants and the regulation of cell differentiation through oral and written communication using scientific vocabulary.
8. Demonstrate responsibility when using technological tools to communicate scientific information related to developmental biology, both in written and oral form.
9. Demonstrate skills in the care and upkeep of living organisms at different stages of development.
10. Work as a team and achieve the solution to scientific problems collaboratively.
11. Compare gametogenesis, fertilization, and segmentation processes in different groups of animals.
12. Analyze and compare early embryonic development from cell determination to gastrulation in different groups of organisms.
13. Evaluate the use of scientific methodology in problem solving through hands-on laboratory experiences.
14. Recognize and analyze how scientific techniques have made it possible to learn about the molecular and cellular mechanisms in the development of organisms.

CONTENTS

- I. Introduction to Developmental Biology
 - A. History of development
 - 1. Theory of preformation
 - 2. Theory of epigenesis
 - B. Cell function during development
 - 1. Molecular genetics basics
 - a. DNA structure
 - b. Genetic expression
 - 2. Cell cycle
 - a. Stages: G₁, S, G₂, Mitosis and G₀
 - 3. Cell morphology and cytoskeleton
 - 4. Transport through the membrane
 - 5. Cell movement
 - 6. Receptors
 - 7. Cell types and histological combinations
- II. Regulation of gene expression during development
 - A. Genomic constancy
 - 1. Nuclear transplantation in amphibians
 - a. Interactions between nucleus and cytoplasm
 - b. Potentiality of the nucleus
 - 1) Embryonic cell nuclei
 - 2) Post-embryonic cell nuclei
 - c. Serial transplantation
 - d. Mitotic incompatibility
 - 2. Nuclear transplantations in mammals
 - a. Cloning
 - B. Differential gene expression
 - 1. Mechanisms
 - a. Polytene chromosomes
 - b. chromatin structure (e.g., heterochromatin, histones, etc.)
 - c. Transcription factors
 - d. DNA methylation
 - C. Cell fate determination
 - 1. Study methods
 - a. Fate mapping
 - b. Cell lineage
 - 2. Ooplasmic determinants
 - a. Egg polarity

3. Principles of induction
 - a. Axes and body planes
 - b. Mesodermal induction
 - c. Instructive and permissive inductions
 - d. Molecular nature of inducers
 - 1) Hormones and Growth Factors
 - 2) Inositol trisphosphate, retinoic acid, and other signal molecules
 - 3) Extracellular matrix
 4. Cell-to-cell interactions
- III. Gametogenesis: oogenesis and spermatogenesis
- A. Interaction between germ and somatic cells
 - B. Cell differentiation
 - C. Hormonal regulation
 - D. Gene expression
- IV. Fertilization
- A. Interactions between egg and sperm
 1. Before adhesion
 - a. Chemoattraction
 2. Adhesion
 - a. Acrosomal reaction
 - B. Fusion of gametes
 - C. Egg activation
 - D. Polyspermy blockage
 - E. Parthenogenesis
- V. Segmentation
- A. Cell Cycle Regulation
 1. Cycle speed during the early stages
 - B. Segmentation Patterns
 1. Types of eggs according to the amount of yolk
 - C. Stages
 1. Morula
 2. Blastula
 3. Segmentation regulation
- VI. Gastrulation
- A. Embryo polarization
 - B. Establishment of the body plan
 - C. Germinal layers: ectoderm, mesoderm, endoderm
 1. Derivates
 - D. Cellular movements: morphogenesis

1. Function of the cytoskeleton
2. Function of the extracellular matrix
3. Migratory routes
4. Intercellular adhesion

VII. Organogenesis

A. Ectodermal organs

1. Neurulation
2. Neural induction
3. Neural tube
4. Neural crest

B. Endodermal organs

1. Digestive tube

C. Mesodermal organs

1. Notochord
2. Somites

VIII. Scientific and Social Importance of Developmental Biology: Moral and Ethical Aspects

A. In vitro fertilization

B. Tissue engineering

C. Cancer

D. Cloning

E. Clinical use of stem cells

1. Bone marrow transplants vs. Umbilical cord cells

F. Ageing

G. Regeneration

H. Use of iPSCs in research and human disease

LABORATORY EXPERIENCES

A. Fertilization and embryonic development in *Marsilea vestita*

B. Fertilization and development of the sea urchin

C. Study of cell regeneration and polarity in planarians

D. Embryonic development of the chicken

E. Morphology of the cancer cell

F. Genotype analysis using PCR

G. Development of *Danio rerio*

H. Development of the starfish

I. Study of gametogenesis in mammals

METHODOLOGY

The following strategies from the active learning methodology are recommended:

- Lectures
- Research based learning
 - Discussion
 - Lab experiences
 - Written lab reports
- Presentations and oral and written reports
- Group work
- Use of WEB 2.0 (Blog and Mi Sagrado)

EVALUATION

Partial assignments	30%
Oral report	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

Gilbert, S. F. (2020). *Developmental biology* (12th ed.). Sinauer Associates.

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ELECTRONIC RESOURCES

<http://www.academicpress.com/db>

<http://cellbio.annualreviews.org/>

https://syllabus.med.unc.edu/courseware/embryo_images/

<http://people.ucalgary.ca/~browder/virtualembryo/amphib2.html>

<http://www.sdbonline.org/sites/archive/dbcinema/kaufman/kaufman.html>

<http://worms.zoology.wisc.edu/urchins/SUmainmenu.html>

<http://www.visembryo.com/baby/index.html>

<http://www.hope-biotechnology.com/?gclid=CP-Voujnw8MCFcnm7AodqlcAMw>

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.

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