B.Sc (Hons.) Biomedical Science

Discipline Specific Core (BIOMED-DSCs)

SEMESTER- VIII

DISCIPLINE SPECIFIC CORE COURSE -20 (BIOMED-DSC-20)

DEVELOPMENTAL BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology BIOMED-DSC-20	4	2	-	2	XII passed	Basic knowledge of Biological Science

Learning Objective:

- This course provides undergraduate students with a comprehensive understanding of embryonic and post-embryonic developmental processes.
- It highlights the remarkable concept that a single fertilized egg can develop into a complex organism. Students will explore fundamental principles at the cellular and molecular levels, using model organisms like Frog, *Drosophila*, Zebra fish Chick etc.
- Additionally, the course delves into the connection between developmental biology and its implications in congenital disorders, human diseases, infertility, IVF, pre-diagnostic methods, and emerging fields like stem cell therapy.

Learning Outcomes:

Upon successful completion of the course, students will be able to:

- Comprehend the sequence of events leading to the formation of a multicellular organism from a single fertilized egg, the zygote.
- Attain fundamental knowledge regarding the cellular processes governing development, including the underlying molecular mechanisms.
- Describe the general patterns and consecutive stages of embryogenesis, elucidating how these processes contribute to the establishment of the body plan in multicellular organisms
- Explain the overarching mechanisms responsible for morphogenesis and articulate how different cells and tissues collaborate harmoniously to generate diverse tissues and organs
- Understand the evolutionary development of the human embryo.

- Appreciate the significance of cutting-edge techniques such as stem cell therapy, *in vitro* fertilization, and amniocentesis in the context of improving human well-being.
- Develop the practical skill set required to cultivate and maintain a laboratory culture of the model system.

SYLLABUS OF BIOMED-DSC-20 **Total 30 hours**

Unit I: Introduction to Developmental Biology. Historical evolution and Basic Concepts: 8 Hours

Origins of Developmental biology and its historical roots: Timeline of discovery of important events in Developmental Biology. Basic concepts, Stages of development, Cell fate, determination, induction, commitment and differentiation. Concept of embryonic stem cell, Mosaic and regulative development, cell-cell lineage, cell to cell communication, Genomic equivalence.

Developmental Mechanisms of Evolutionary Change: "Unity of Type" and "Conditions of Existence", Hox Genes: Descent with Modification. Prerequisites for Evolution via Development: Developmental Correlation, Constraints, and a Fresh Evolutionary Synthesis.

Basic overview of Model Organisms with respect to development process with Human Connection: Frog, Chick, Zebrafish, *Drosophila melanogaster*, *Caenorhabditis elegans.*

Unit II: Early Embryonic Development: 8 Hours

Gametogenesis: Saga of germ plasm, Formation of primordial germ cells, Gametogenesis :Oogenesis and Spermatogenesis with all its stages

Fertilization, Recognition of Egg and Sperm, Gamete Fusion, Fusion of the Genetic Material and Prevention of Polyspermy, Activation of Egg Metabolism, Rearrangement of the Egg Cytoplasm.

Cleavage, formation of Morula, Development and implantation of Blastula and formation of placenta, extraembryonic membranes and their functions

Gastrulation: Formation of three primary germ layers, concept of induction and competence and their commitment to fate, Axis specification (Dorsoventral, anterior posterior), and Body plan patterning, Left right symmetry

Unit III: Later Embryonic Development and Organogenesis: 10 hours

Homologous Development Pathways, Modularity, and Signaling Pathways and molecular regulation of the following Developmental Processes

Ectoderm structures: The central nervous system and the epidermis: Formation and differentiation of the Neural tube, Neural crest, and complete nervous system, Development of the Vertebrate Eye, Epidermis and the Origin of Cutaneous Structures

Mesodermal Structures and their development: Myogenesis, Osteogenesis, Formation of Limb and Heart.

Endodermal structures and their formation: Digestive system

Teratogenesis: Teratogenic agents and their effects on embryonic development

Concept of Genetic Sex determination and formation of Gonads, Infertility: Causes and underlying reasons for infertility.

UNIT: IV Developmental Biology and its Application 4 Hours

Amniocentesis and Assisted Reproductive Technologies (ART): Ovulation Induction (OI), Artificial Insemination (AI), Donor Conception, In Vitro Fertilization (IVF), Intracytoplasmic Sperm Injection

(ICSI), Gamete Intrafallopian Transfer (GIFT), Zygote Intrafallopian Transfer (ZIFT), Preimplantation Genetic Diagnosis (PGD).
Stem Cells and Applications. Cloning Experiments: Reproductive cloning attempts.
Ethical Considerations:Addressing ethical dilemmas in reproductive sciences.

Practical

60 Hours

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs/lab visits etc.)

1. Study of whole mounts and sections of developmental stages of the embryo of man through permanent slides: Cleavage blastula, gastrula, neurula.
2. Study of whole mounts and sections of Developmental stages of bone, muscle , cartilage (photomicrographs/ slides)
3. Study of sections of developmental stages of Human heart
4. Specimen study of Human embryos at various stages of development / Visit to a medical college for specimens
5. Study of sections of human placenta (photomicrographs/ slides)
6. Video recordings and /or photomicrographs on Assisted Reproductive Technologies (ART).
7. Study of various contraceptive methods
8. Project Report on any one of the following: Development of a system/ recent development in ART/ current technologies to study Development.
9. Study of different stages of embryo using a live animal model like zebra fish/ C. elegans/chick

Essential Readings:

- Gilbert, S. F. (2016). Developmental Biology. XI Edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA ISBN-13: 978-1605356044
- Balinsky B. I. and Fabian B. C. (2012). An Introduction to Embryology. V Edition, International Thompson Computer Press. ISBN-13: 978-8131517499
- Slack, J.M.W. (2012) Essential Developmental Biology. III Edition, Wiley- Blackwell. ISBN-13: 978-0470923511

Suggested Readings:

- Lewis, W. and Rosa, B. (2001) Principles of Development. II Edition, Oxford University Press. ISBN-13: 978-0198792918
- Carlson, B.M. (2007) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers. Arora, R. and Grover, A. (2018) Developmental Biology: Principles and Concepts. I Edition, R. Chand & Company

Websites and Review articles

- https://www.hhmi.org/biointeractive/human-embryonic-development
- https://ocw.mit.edu/courses/biology/7-22-developmental-biology-fall-2005/index.htm
- Burgaud, M. Bretin, B. Reignier, A. Vos, J. D. and David, L. (2023) New models to study human embryonic development, Med Sci (Paris). 2023 Feb;39(2):129-136