Course Objectives:

The course aims to:

1. Provide information on transmission of traits from the parents in their gametes, the formation of zygote and its development
2. Impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction.
3. Provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis.

Course Learning Outcomes:

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

1. **Gain** familiarity with features that make an organism model for the learning of developmental biology *e.g.,* fertilization in sea urchin with mammalian like mechanisms.
2. **Apprehend** the contributions of the sperm and the egg to form zygote
3. **Elucidate** the problems associated with cell differentiation through fate mapping.
4. **Arrange and investigate** the classical and modern experiments into "find it", "block it", and "move it" categories
5. **Assess** the set of experiments that will establish whether a planned aspect is both necessary and ample to cause a developmental episode
6. **Demonstrate** the ability to label macromeres, mesomeres, and micromeres and know which cell types are derived from each of these cell layers in the early embryo (*e.g.,* primary and secondary mesenchyme, ectoderm, endoderm, and mesoderm).

Course Outline:

1. Introduction

- History and Basic Concepts of Developmental Biology
- Principal features of developmental biology and embryology with special emphasis on vertebrate models
- Origin of sexual reproduction
- Developmental patterns

2. Spermatogenesis

- Mammalian spermatogenesis as model for all vertebrates
- Spermiogenesis or (spermateliosis)
- The role of Sertoli and Leydig cells in spermatogenesis
- Hormonal control of spermatogenesis

3. Primates Menstrual cycle

4. Oogenesis

- Mechanism of oogenesis among various classes of vertebrates.
- Vitellogenesis
- Hormonal control of Vitellogenesis and oogenesis

5. Fertilization

- External & Internal Fertilization
- Species-specific recognition of sperm and egg
- Fusion of male and female gametes
- Polyspermy: slow and fast blocks to polyspermy
- Activation of egg metabolism

6. *IN VITRO* Fertilization (IVF)

- History, Steps and advantages of IVF
- Disadvantages and risk factors

7. Cleavage & Blastulation

- Patterns of embryonic cleavage and blastulation among different vertebrate classes
- Mechanism of cleavage.

8. Gastrulation

- Fate maps
- Gastrulation in amphibians, birds and mammals

9. Early Vertebrate Development

- Neurulation, ectoderm, mesoderm and endoderm formation

10. Placenta and extra embryonic membranes

11. Cellular Basis of Morphogenesis

- Differential cell affinity, cell adhesion molecules
- Organogenesis
- Mechanism of Teratogenesis

12. Aging and Regeneration in vertebrates

Practical:

1. Study of the structure of gametes in some representative cases, *i.e.* Frog, Fish and Mammal.
2. Hen's egg internal and external structural details
3. Microscopic analysis of hen's egg yolk, albumin and shell membranes
4. Study of cleavage and subsequent development from prepared slides and/or models in various animals i.e., frog, mammals and chick etc.
5. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
6. Study of developmental stages of nematodes through microscopic analysis of animal dung
7. Semen analysis
8. Dactylography and its uses in Developmental Biology

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Text and Reference Books:

1. Gilbert, S. F. 2013. Developmental Biology, Sinauer Associates, Sunderland, MA.
2. Klaus, K. 2001. Biological Development. 2nd Ed., McGraw-Hill.
3. Scott F. Gilbert and Michael J. F. Barres. 2016. Developmental Biology. Sinauer Associates, Sunderland, MA.
4. Jamie. A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA
5. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
6. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
7. Saunders, J. W. 1982. Developmental Biology, McMillan and company.
8. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.