Semester VII

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		
Developmen tal Biology (BCH-DSE-11)	4	2L		2P	Class XII with Science and Biology	-

Learning Objectives

The objective of this course is to provide basic knowledge of the development processes, different molecular and cellular mechanisms which are involved in animal development. This course would also highlight the importance of different animal models in the study of developmental processes. The course would also give knowledge about the concept of stem cells, totipotency.

Learning Outcomes

On successful completion of the course, students will:

- Students will acquire knowledge about basic concepts of developmental processes, fertilization, germ layer formation and patterning of body plan.

- Students will gain detailed insight into the molecular events of embryogenesis, importance of various model systems and their applications in understanding human development and associated defects.

- Students will learn about Stem cells, their roles in development and significance in development of regenerative medicines, current applications and advancement in stem cell research.

SYLLABUS OF DSE-11

BCH-DSE-11: DEVELOPMENTAL BIOLOGY

Semester – VII

Theory

Credits: 2 **Total Hours: 30**

UNIT 1: Introduction to Developmental Biology **No of hours: 10**

History, Evolutionary embryology and Basic concepts of developmental biology, Overview of fertilization, early development- Patterns of cleavage, germ layer formation, implantation, placentation, Formation of blastula, embryogenesis: Nieuwkoop center, Spemann-Magold organizer theory and mesodermal induction, Gastrulation, Fate maps, and neural tube formation.

UNIT 2: Molecular biology of development **No of hours: 6**

Role of differential gene expression in development, Role of cell-cell communication in development. Key signaling pathways in development: Fgf, Hedgehog, Wnt, TGFß, and Notch. Cadherins in establishing intercellular connections, Role of extracellular matrix in development Concepts of induction and competence and senescence.

UNIT 3: Study on model organisms **No. of hours: 8**

Caenorhabditis elegans: Study of cell lineage, mosaic development and organogenesis (vulva formation).
Drosophila melanogaster: Role of maternal effect genes, morphogens and zygotic genes (Gap genes to homeotic genes) in axis formation and body patterning.
Danio rerio (Zebra fish)*:* Study various early embryogenesis stages starting from the zygote - cleavage - blastula - gastrula - segmentation, pharyngula, hatching and early larval development.
Study mechanisms of pigmentation and stripe
patterning in fish skin.

UNIT 4: Stem cells and their implications in treatment strategies: No of hours: 4

Stem cells and their types, Pluripotent cells, Induced pluripotent stem cells and their applications in human development and diseases. Ethical issues.

UNIT 5: Developmental defects and the role of teratogens: No. of hours: 2

Chemical, physical and biological agents which can cause developmental defects. Brief discussion of alcohol and retinoic acid as teratogenic agents.

2.3 Practical:

Credit: 2 Total Hours: 60

1. Study of life cycle and developmental stages of Zebrafish.
2. Live demonstration of Zebrafish embryogenesis: Microscopic visualization of early cleavages, sphere stage, shield stage, gastrulation, epiboly and somite formation.
3. Study of life cycle and developmental stages of Drosophila melanogaster
4. Study of developmental stages of chick embryo. (optional)
5. Study of life cycle and developmental stages of *C. elegans.*

Essential Readings

1. Gilbert, S.F. and Barresi, M.J.F. (2017), Developmental Biology, 11th Edition 2016. Am. J. Med. Genet., 173: 1430-1430. https://doi.org/10.1002/ajmg.a.38166.
2. Basson M. A. (2012). Signaling in cell differentiation and morphogenesis. Cold Spring Harbor perspectives in biology, 4(6), a008151. https://doi.org/10.1101/cshperspect.a008151
3. Kimmel, C.B., Ballard, W.W., Kimmel, S.R., Ullmann, B. and Schilling, T.F. (1995), Stages of embryonic development of the zebrafish. Dev. Dyn., 203: 253-310. https://doi.org/10.1002/aja.1002030302
4. Alberts, B. (2015) Molecular Biology of the Cell. 6th Edition, Garland Science, Taylor and Francis Group, New York.
5. Wolpert, L., Tickle, C., Martinez, A. A., Lawrence, P., & Locke, J. (2019). Principles of development. Oxford, United Kingdom; New York, NY: Oxford University Press, [2019]
6. Balinsky, B.L. (2008). An introduction to embryology. 5th edition. Thomson Publishers.

Suggested Readings:

1. Davies, J. (2004). Practical guide to developmental biology. BioEssays, 26, 1142.
2. Gibbs, M., A. (2003) A Practical Guide to Developmental Biology. Oxford University Press, 2003 ISBN 0199249717, 9780199249718
3. ZFIN Protocols

3. Teaching Learning Process and Assessment Methods Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks

I	Students will learn about basic concepts of developmental processes, how cell fate is determined.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
II	Students would learn about the role of key signaling pathways in development	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
III	Students would learn about the role of various model systems in the study of development Biology	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

IV	Students would learn about stem cells and their applications	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
V	Students would learn about various developmental defects and effect of teratogens	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

4. Key words

Developmental stages, signaling pathways, model organisms, stem cells, teratogens