University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK5DSCZOO301**				
Course Title	**Developmental Biology**				
Type of Course	**DSC**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class 12				
Course Summary	Developmental biology explores the intricate processes governing organisms' growth, differentiation, and morphogenesis from conception to maturity. Key topics in this course include gametogenesis, fertilization, fate mapping, potency, and regeneration. Advanced concepts such as prenatal diagnostics, in vitro fertilization, and cryopreservation are also covered. Through lectures, labs, and activities, students gain a deep understanding of developmental principles and their relevance to human health. Emphasis is placed on critical thinking and interdisciplinary approaches, preparing students for diverse career paths in research, medicine, biotechnology, and education.				

Detailed Syllabus: Developmental Biology
Theory: Credit - 3 (Total 45 hours)

Module	Unit	Contents	45 Hrs
I	**Gametogenesis and Early Embryonic Development**		**10**
	1.1	Gametogenesis: Spermatogenesis and Oogenesis, Structure of Graafian follicle, typical egg and sperm.	3
	1.2	Egg envelopes, Classification of eggs (Based on the presence or absence of shell, amount of yolk, distribution of yolk, and pattern of development). ***Related Activity*** Group activity :*Prepare a poster showing different types of eggs*	2

	1.3	Process of Fertilization: Agglutination, Acrosome reaction, Activation of egg, Amphimixis. Polyspermy: Primary and secondary block to polyspermy (Brief account only).	2
	1.4	Cleavage: Patterns and types of cleavage (Holoblastic and meroblastic).	2
	1.5	Blastulation (Brief account only), Types of Blastula	1
II	**Late Embryonic Development**		**11**
	2.1	Fate Map and its significance, Construction of Fate map - Mention different techniques (Natural markings and artificial -Vital staining, carbon particle marking, Radioactive labelling, Genetic Marking), Fate map of the frog.	3
	2.2	Concept of gastrulation. A brief account of morphogenetic movements: Epiboly and Emboly (Invagination, Involution, Infiltration, Ingression, Delamination, Convergence, Divergence). Gastrula of frog-structure. ***Related activites*** *Group activity :1.Prepare a chart showing the salient features of 24 hr Chick embryo .* *2.Visit to poultry farm and prepare a report on the development of chick embryo*.	3
	2.3	Concept of germ layers, Derivatives of germ layers (Ectoderm, Endoderm and Mesoderm).	1
	2.4	Development of Man - Implantation, Pregnancy (Brief account only).	2
	2.5	Placentation in mammals: Functions of the placenta, Classification (based on the type of foetal membranes, mode of implantation, nature of the contact, distribution of chorionic villi and histological intimacy).	2
III	**Implications of Developmental Biology**		**6**
	3.1	Concept of Potency in embryonic cells: Totipotency, Pluripotency, and Unipotency. Mention the role of stem cells in post-embryonic development.	2
	3.2	Determination and differentiation in embryonic development. Genes involved in the development of Drosophila. (Brief account only).	2
	3.3	Significance of organizer and embryonic induction (Brief account only). Mention Spemann-Mangold experiment.	2
	Techniques in Developmental Biology		**9**

IV	4.1	Prenatal diagnostic techniques: Amniocentesis, Alpha-Foetal Protein (AFP) estimation, Chorionic villus sampling, and Ultrasound scanning.	3
	4.2	*In vitro* fertilization (IVF) and embryo transfer in humans, Test tube baby technique – procedure and brief description.	2
	4.2	Assisted Reproductive Techniques: GIFT, ZIFT, TET, ICSI.	2
	4.3	Cryopreservation of gametes and embryos - Explain Vitrification and controlled rate freezing. ***Related activities*** *Group activity- 1. Prepare a PowerPoint presentation on Assisted Reproductive Techniques* *2.Conduct a debate on the ethical issues related to human embryo research.*	2
V	**Special processes in Developmental biology**		**9**
	5.1	Regeneration: Modes of regeneration (Epimorphosis, Morphallaxis, Heteromorphosis and Compensatory regeneration with one example each).	3
	5.2	Parthenogenesis: Definition, Natural (Arrhenotoky and Thelytoky, (Obligatory and Facultative) and Artificial parthenogenesis. Significance of parthenogenesis .	3
	5.3	Teratology: Teratogenic agents -Drugs and chemicals, Infectious agents like viruses and bacteria, Ionizing radiations, Metabolic imbalance, Malnutrition) and their effect on embryonic development (Brief account only).	3

Recommended Reading

1. Michael J.F. Barresi and Scott F. Gilbert (2020). Developmental Biology, OUP USA; 12th edition.
2. Jonathan M.W. Slack and Leslie Dale (2021). Essential Developmental Biology. Wiley-Blackwell, 4th edition.
3. Gilbert, S.F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
4. Balinsky B.I. and Fabian B.C. (2006). An Introduction to Embryology. VIII Edition, International Thompson Computer Press.
5. Carlson, B.M. (2007) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.

Suggestive Reading

1. Kay Elder and Brian Dale (2020). In-Vitro Fertilization. Cambridge University Press; 4th edition.
2. Subramanian M.A. Developmental Biology, M J P Publisher; First Edition (1 November 2021).

3. Kalthoff, K. (2001) Analysis of Biological Development. II Edition, McGraw Hill Publishers.
4. Arora, R. and Grover, A. (2018). Developmental Biology: Principles and Concepts. I Edition, R Chand & Company.
5. Berry, A. K. (2008). An Introduction to Embryology. Emkay Publications.
6. Goel, S.C. (1984). Principles of animal developmental biology. Himalaya Publ. House, Bombay.
7. Verma, P.S. & Agarwal V.K. (2010). Chordate Embryology. S. Chand & Company Ltd.
8. Varsha Baweja and Monica Misra (2021). Practical Manual of Developmental Biology, ebook.

PRACTICUM
Developmental Biology
Credit - 1 (30 hours)
Any five including one major practicum is compulsory

Sl. No	**Content**
1.	Mount, sketch and label 24hr chick blastoderm (Major practical)
2	*In vivo* study of chick embryo development by windowing and candling methods (Major practical)
3	Study the following specimens- Blastula of frog, gastrula of frog, hen's egg, Human sperm, Human egg (Any three). Use Slide/Model/Picture (Spotter).
4	Study of different types of placenta - Human and Sheep. Use Slide/Model/Picture /specimen (Spotter).
5	Prepare a poster on the developmental stages of frogs (Group activity).
6	Renowned embryologists around the world (Hans Spemann, Sir John Gurdon, Ian Wilmut, Dr. Subhas Mukhopadhyay) (Spotters).
7	Visit an IVF Centre and make a report on assisted reproductive techniques.

REFERENCES

1. Michael J.F. Barresi and Scott F. Gilbert (2020). Developmental Biology, OUP USA; 12th edition.
2. Verma, P. S. & Agarwal V.K. (2010). Chordate Embryology. S. Chand & Company Ltd.
3. Varsha Baweja and Monica Misra (2021). Practical Manual of Developmental Biology, ebook.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand and apply the principles of gametogenesis, fertilization, egg classification, cleavage, and blastulation in animals, and analyse and evaluate their developmental significance.	R, U, Ap, An, E, C	1, 2,3,
CO-2	Understand and apply the concepts of fate maps, morphogenetic movements, germ layers, implantation, pregnancy, and placentation in vertebrate development, and analyse and evaluate their developmental significance.	R, U, Ap, An, E,C	1, 2,3.4,
CO-3	Recall, understand, and apply the concepts of potency, determination, differentiation, embryonic induction, stem cells, and developmental genes in embryogenesis, and analyse and evaluate their significance in development.	R, U, Ap, An, E,C	1, 2,3,4,5
CO-4	Understand, analyse, and evaluate prenatal diagnostic techniques, assisted reproductive technologies, IVF, cryopreservation methods, and their ethical implications in developmental biology.	R, U, Ap, An, E,C	1, 2,3, 4
CO-5	Recall, understand, apply, analyse, and evaluate the concepts of regeneration, parthenogenesis, and teratology, including their types, mechanisms, significance, and effects on embryonic development in developmental biology.	R, U, Ap, An, E,C	1, 2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Developmental Biology
Credits: 3:0:1 (Lecture:Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand and apply the principles of gametogenesis, fertilization, egg classification, cleavage, and blastulation in animals, and analyse and evaluate their developmental significance.	PO- 1, 2/ PSO- 1, 2, 6	R, U, Ap, An, E,C	F, C	L	P

CO-2	Understand and apply the concepts of fate maps, morphogenetic movements, germ layers, implantation, pregnancy, and placentation in vertebrate development, and analyse and evaluate their developmental significance.	PO-1,2/ PSO-1, 2,6	R, U, Ap, An, E,C	F, C	L	P
CO-3	Recall, understand, and apply the concepts of potency, determination, differentiation, embryonic induction, stem cells, and developmental genes in embryogenesis, and analyse and evaluate their significance in development.	PO-1, 2,6/ PSO-1,2, 4,5, 6	R, U, Ap, An, E,C	C, P	L	P
CO-4	Understand, analyse, and evaluate prenatal diagnostic techniques, assisted reproductive technologies, IVF, cryopreservation methods, and their ethical implications in developmental biology.	PO-1,6,8/ PSO-1, 2, 5,7	R, U, Ap, An, E,C	F, C	L	P
CO-5	Recall, understand, apply, analyse, and evaluate the concepts of regeneration, parthenogenesis, and teratology, including their types, mechanisms, significance, and effects on embryonic development in developmental biology.	PO-1, 2, 8/ PSO-1, 2,4,5	R, U, Ap, An, E, C	F, C	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	3	2	-	-	-	1	-	1	-	-	-	-	2	-	-
CO 2	2	2	-	-	-	-	-	1	-	-	-	-	-2	-	-
CO 3	3	2	-	1	2	1	-	1	-	-	-	2	2	-	-
CO 4	3	3	-	2	-	-	-	-	-	-	-	-	2	1	
CO 5	3	2	-	1	1	-	-	1	-	-	-	2	2	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignments (Any two)

1. Explore the mechanisms of gastrulation in frog.
2. Describe the mechanisms of gastrulation of chick.
3. Discuss the role of environmental factors in influencing developmental processes.
4. Investigate the role of stem cells in tissue regeneration and embryonic development.
5. Explore the impact of teratogens on foetal development and congenital abnormalities.

Continuous Comprehensive Assessment

1. Assignments
2. Seminar/PowerPoint presentations
3. Submission of report
4. Submission of Field report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	✓	-	✓