Syllabus template

Semester: 8	
Course : Major	
Paper Title: Developmental Biology and Neuroscience	
Paper code: C4BT230811T	**Credits: 4**
Hours/week : 4	
Category: Core/MDC/SEC/VAC : Core	
Theory / Practical / Composite : Theory	
No of Modules : 2	

Course Overview:

1. To provide a comprehensive understanding of the principles of developmental biology and the processes of early embryonic development.
2. To explore the molecular, cellular and genetic mechanisms underlying organogenesis and development and the effects of the environment upon development.
3. To provide an overview of stem cell biology and its applications and of the processes of regeneration and senescence.
4. To provide an advanced foundation in neuroscience encompassing the neural basis of learning and memory, the architecture of human cognition and modern neurocognitive aspects.
5. To provide physiological and clinical dimensions of human reproduction and early development, including gametogenesis, fertilization, endocrine regulation, and the technologies addressing infertility and diagnostic challenges.
6. To acclimatize the students with in-depth knowledge of the various aspects of developmental biology and neuroscience.

Course Outcome:

Module A

1. Outline the fundamentals of vertebrate embryogenesis, organogenesis, stem cell biology, regeneration and senescence.
2. Describe and explain the mechanisms and significance of developmental processes such as blastulation, gastrulation, embryonic organizers, gene regulation during development neurulation, environmental regulation of development, stem cell biology, regeneration and senescence.
3. Apply knowledge and principles of vertebrate embryogenesis, organogenesis, stem cell biology, regeneration and senescence to interpret stages of development and applications in tissue repair and age-related biological processes.
4. Analyze the relationship between cleavage patterns, morphogenetic movements and embryonic organizers in establishing body plan of developing embryos and interactions between genes and cellular processes involved in organogenesis, limb development and associate the molecular and cellular basis of stem cell function, regeneration and ageing.
5. Evaluate the significance of processes such as formation of germ layers, embryonic organizers, genetic and environmental influences on developmental processes and potential benefits and limitations of stem cell research and regeneration.
6. Develop a comprehensive overview of vertebrate embryogenesis, organogenesis, stem cell biology, regeneration and senescence.

Module B

1. Identify and recognize the basic functional anatomy of the human reproductive system, key steps of gametogenesis, concept of the reproductive cycle, and functional and structural aspects of neuroethology and human cognition.
2. Describe and explain the functional and anatomical features of reproductive physiology, mechanisms of fertilization, functional cortical organization, and the neural basis of emotion and metacognition.
3. Apply developmental and neuronal principles to interpret and implement clinical methodologies, such as semen analysis parameters, steps of Assisted Reproductive Techniques (ART), and practical frameworks for cognitive interventions.
4. Analyze various aspects of neuroethology, including instinctive and learned behaviors, fixed action patterns, metacognition, and functional relevance of various domains of reproductive physiology and medicine.
5. Evaluate the impact of functionality, clinical efficacy and diagnostic accuracy in terms of clinical reproductive science alongside therapeutic neurocognitive interventions.
6. Develop a comprehensive conceptual framework that integrates sensory-motor pathways, endocrine regulation, and neural mechanisms to address neurocognition, neuroethology and reproductive physiology.

Prerequisites: ***Basic knowledge about cell biology, animal biology, physiology and genetics***

SYLLABUS

UNIT/Module	**CONTENT**	**HOURS or NUMBER OF CLASSES**	**CO Mapping**	**COGNITIVE LEVEL**
Module A	**Unit I: Fundamentals of Vertebrate Embryogenesis:** Fate maps, cleavage patterns and blastulation, morphogenetic movements, gastrulation and formation of germ layers in vertebrates, embryonic organizers and axis formation. **Unit II: Organogenesis and Development:** Multicellularity and evolution of differentiation, gene regulation during development (maternal effect and segmentation genes, homeotic gene complexes, *Hox* genes), neurulation and development of the brain, environmental regulation of development, environmental disruption of normal development (teratogens, endocrine disruptors). **Unit III: Stem Cell Biology, Regeneration and Senescence:** Embryonic and adult stem cells, induced pluripotent stem cells, stem cell therapies, cord blood stem cells. Ethical issues related to stem cell research. Epimorphosis, morphallaxis and compensatory	2 classes per week	CO1-CO6	K1-K6

	regeneration with examples. Ageing and biology of senescence.			
Module B	**Unit IV: Early Embryonic Development and Reproductive Physiology:** (a) Basic functional anatomy of human reproductive system, concept of reproductive cycle (b) Reproductive endocrinology (c) Spermatogenesis and Oogenesis (d) Capacitation, Fertilization, Monospermy. **Unit V: Reproductive Health and diagnostics:** (a) Problems of Infertility, Semen analysis (b) Assisted Reproduction Techniques in human (c) Prenatal and Postnatal diagnosis. **Unit VI: Neuroethology:** (a) Functional neuroanatomy and Neural plasticity. (b) Instinctive and learned behavior, fixed action patterns, memory. **Unit VII: Cognitive Neuroscience and Sensory-Motor Integration:** (a) Functional cortical organization and metacognition (b) Concept of cognitive neuroscience, metacognitive perspectives, neural basis of emotion (c) Cognitive interventions (d) Relevance of neurotransmitters in neurological health and disorders.	2 classes per week	CO1-CO6	K1-K6

Text Books and Suggested readings
Module A
1. S.F. Gilbert. Developmental Biology.
2. B.M. Carlson. Foundations of Embryology.
3. G.M. Cooper, R.E. Hausman. The Cell – A Molecular Approach.
4. Relevant scientific literature.
Module B
5. J.E. Hall. Guyton and Hall Textbook of Medical Physiology.
6. K. Barrett, S. Barman et al. Ganong's Review of Medical Physiology.
7. Kandel, E.R., Koester, J.D., Mack, S.H., and Siegelbaum, S.A. Principles of Neural Science.
8. Gazzaniga, M.S., Ivry, R.B., and Mangun, G.R. Cognitive Neuroscience: The Biology of the Mind.
9. S.F. Gilbert. Developmental Biology.
10. B.M. Carlson. Foundations of Embryology.
11. Relevant scientific literature

Evaluation: Theory: CIA: 30 marks; Semester Exam: 70 marks
Paper Structure for Theory Semester Exam Module: **Module A (35 marks)** Answer any five out of seven questions, each of 7 marks with subparts. [No sub-part will be less than 2 marks or more than 5 marks] **Module B (35 Marks)** Subjective Questions: Answer any five out of seven questions, each of 7 marks with subparts. [No sub-part will be less than 2 marks and more than 5 marks]

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
	Module A	
CO1	Outline the fundamentals of vertebrate embryogenesis, organogenesis, stem cell biology, regeneration and senescence.	K1
CO2	Describe and explain the mechanisms and significance of developmental processes such as blastulation, gastrulation, embryonic organizers, gene regulation during development neurulation, environmental regulation of development, stem cell biology, regeneration and senescence.	K2
CO3	Apply knowledge and principles of vertebrate embryogenesis, organogenesis, stem cell biology, regeneration and senescence to interpret stages of development and applications in tissue repair and age-related biological processes.	K3
CO4	Analyze the relationship between cleavage patterns, morphogenetic movements and embryonic organizers in establishing body plan of developing embryos and interactions between genes and cellular processes involved in organogenesis, neurulation and development and associate the molecular and cellular basis of stem cell function, regeneration and ageing.	K4
CO5	Evaluate the significance of processes such as formation of germ layers, embryonic organizers, genetic and environmental influences on developmental processes and potential benefits and limitations of stem cell research and regeneration.	K5
CO6	Develop a comprehensive overview of vertebrate embryogenesis, organogenesis, stem cell biology, regeneration and senescence.	K6
	Module B	
CO1	Identify and recognize the basic functional anatomy of the human reproductive system, key steps of gametogenesis, concept of the reproductive cycle, and functional and structural aspects of neuroethology and human cognition.	K1
CO2	Describe and explain the functional and anatomical features of reproductive physiology, mechanisms of fertilization, functional cortical organization, and the neural basis of emotion and metacognition.	K2
CO3	Apply developmental and neuronal principles to interpret and implement clinical methodologies, such as semen analysis parameters, steps of Assisted Reproductive Techniques (ART), and practical frameworks for cognitive interventions.	K3

CO4	Analyze various aspects of neuroethology, including instinctive and learned behaviors, fixed action patterns, metacognition, and functional relevance of various domains of reproductive physiology and medicine.	K4
CO5	Evaluate the impact of functionality, clinical efficacy and diagnostic accuracy in terms of clinical reproductive science alongside therapeutic neurocognitive interventions.	K5
CO6	Develop a comprehensive conceptual framework that integrates sensory-motor pathways, endocrine regulation, and neural mechanisms to address neurocognition, neuroethology and reproductive physiology.	K6