ZOOLOGY-NEP-UGCF-4th YEAR

GE PAPERS

SEMESTER – VII

List of GE Papers

Course Title	Nature of the Course	Total Credits	Components			Page No.
			Lectures	Tutorial	Practical	
Principles of Developmental Biology	Zoo-GE-17	4	2	Nil	2	19
Biology of Animal Cells	Zoo-GE-18	4	2	Nil	2	22
Immunology: Understanding the body's defense mechanisms	Zoo-GE-19	4	2	Nil	2	25
Concepts of Human Metabolism	Zoo-GE-20	4	2	Nil	2	28

GENERIC ELECTIVE COURSE -17

Principles of Developmental Biology

Zoo-GE -17

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)	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Principles of Developmental Biology **Zoo-GE-17**	04	02	Nil	02	XII Class	Nil	Zoology

Learning Objectives

The learning objectives of this course are to:

- Identify the basic principles of developmental biology
- Understand the mechanisms associated with the development of organ system of the human body
- Acquaint the students with the fascinating transformation of a single cell (fertilised egg) into a fully developed, complex organism.
- Explain the basic principles and concepts underlying morphogenesis.
- Be able to investigate the effects of environmental factors on embryonic development.

Learning Outcomes

By studying this course, students will be able to:

- Understand the process and significance of formation of haploid germ cells
- Interpret the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
- Understand the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of the body plan of multicellular organisms.

- Gain knowledge of the general mechanisms involved in morphogenesis and to explain how different cells and tissues interact in a coordinated way to form various tissues and organs.
- Become aware of the effects of pollutants/chemicals on abnormal embryonic development.

SYLLABUS

THEORY **(30 hrs)**

UNIT- 1: Introduction and Historical perspectives **2 hrs**

Definition and scope of developmental biology; Importance of embryology in medicine and biology.

UNIT- 2: Gametogenesis, Fertilization and Placentation **14 hrs**

Spermatogenesis and oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal), Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula. Types of placenta (shape and structure), Functions of Placenta, Amniocentesis.

UNIT- 3: Gastrulation **8 hrs**

Process of Gastrulation in frog and chick. Fate of the three germ layers: ectoderm, mesoderm, and endoderm.

UNIT- 4: Metamorphosis and Teratology **6 hrs**

Metamorphosis of Amphibian larvae to Adult. Teratogenesis, Teratogenic agents and their effects on embryonic development.

PRACTICALS **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula (Neural plate, Neural fold and Neural tube stages), tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): primitive streak stage, head process stage, head fold stage, 4-somite stage, 13-somite stage, 16-somite stage, 37-somite stage
3. Types of placentas with the help of photomicrographs/ slides.

PROJECT WORK

Project report on *Drosophila* or any insect culture/Visit to Poultry Farm/IVF Centre.

Essential/recommended readings

1. Slack, J.M.W. (2013) Essential Developmental Biology. III Edition, Wiley- Blackwell.
2. Gilbert, S. F. (2010). Developmental Biology. IX Edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA
3. Balinsky, B. I. and Fabian B. C. (2006). An Introduction to Embryology. VIII Edition. International Thompson Computer Press.
4. Wolpert, L. (2002). Principles of Development. II Edition, Oxford University Press.

Suggested readings

1. Baweja, V. and Misra, M. (2021). E-book on Practical Manual of Developmental Biology.

2. Arora, R. and Grover, A. (2018). Developmental Biology: Principles and Concepts. 1st Edition, R. Chand & Company.

3. Carlson, B.M. (2007.) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE -18

Biology of Animal Cells

Zoo-GE -18

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	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Biology of Animal Cells **Zoo-GE-18**	04	02	Nil	02	XII class	Nil	Zoology

Learning Objectives

The learning objectives of this course are to:

- Explore the diversity of the cells ranging from unicellular to multicellular organisms
- Explore the different models of the plasma membrane and various modes of transport across them
- Understand the fundamental structure of cell and its various functions.
- Examine the structural details of the cell organelles in relation to their role in the organism.
- Investigate the process of cell division and its relevance in the continuation of the species
- Analyse the various practical techniques to study the cell and its function.

Learning Outcomes

By studying this course, students will be able to:

- Explain the fundamental and functional principles of different types of cells
- Describe the structure and various models of plasma membrane and its role in transport of materials across cells
- Analyze the organizational details of key cell organelles involved in diverse cellular processes.

- Appreciate the characteristics of cellular growth, division, survival and death to regulate these important processes.
- Comprehend the process of cell division and its role in cellular cycle.
- Gain insights into the defects in functioning and regulation of cell organelles leading to diseases.
- Apply practical skills to understand the different cell division methods.

SYLLABUS

THEORY **(30 hrs)**

Unit 1: Types of Cells and Plasma Membrane **7 hrs**

Virus, Viroids, Mycoplasma, Prokaryotic and Eukaryotic cells. Different structures and models of plasma membrane, Transport across membranes: active and passive transport, facilitated transport; Cell-cell junctions: Tight junctions, adherens junctions, gap junctions.

Unit 2: Endo-membrane System **6 hrs**

Structure and Functions: Endoplasmic Reticulum, Vesicular transport from ER to Golgi apparatus; Protein sorting and transport from Golgi apparatus; Golgi apparatus, Vesicular transport: Coated Vesicles; Lysosomes; Peroxisomes.

Unit 3: Mitochondria and Cytoskeleton **8 hrs**

Endo-symbiotic hypothesis; Respiratory chain, Chemi-osmotic hypothesis. Microtubules, Microfilaments and Intermediate filaments.

Unit 4: Nucleus and Cell Division **9 hrs**

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Transport of molecules across nuclear membrane, Chromatin: euchromatin, heterochromatin and packaging, nucleosome, nucleolus. Mitosis, meiosis and regulation of cell cycle.

PRACTICALS **(60 hrs)**
(Laboratory periods: 15 classes of 4 hours each)

1. Principles of Microscopy: Compound microscope: Phase contrast microscope; Electron microscope; Differential Interference Contrast (DIC) Microscope.
2. Principle and types of cell fixation and staining; Cell fractionation.
3. Study of prokaryotic cells by Gram staining and eukaryotic cells (cheek cells) by staining with hematoxylin/methylene blue.
4.Study the effect of hypotonic, isotonic, and hypertonic solutions on cell permeability.
5. Preparation of a temporary slide of squashed and stained onion root tip to study various stages of mitosis.

6. Study of various stages of meiosis through permanent slides.
7. Preparation of stained mount to show the presence of Barr body in human female WBCs /cheek cells.

Essential/recommended readings:

1. Cooper, G.M., Hausman, R.E. (2019). The Cell: A Molecular Approach. VIII Edition, ASM Press and Sinauer Associates.
2. Becker, Kleinsmith, and Hardin (2018). The World of the Cell, IX Edition, Benjamin Cummings Publishing, San Francisco.
3. Karp, G. (2015). Cell and Molecular Biology: Concepts and Experiments, VIII Edition, John Wiley & Sons Inc.

Suggested readings:

1. Renu Gupta, Seema Makhija and Ravi Toteja (2018). Cell Biology Practical Manual, Prestige Publishers, New Delhi

2. V. K Sharma (1991). Techniques in Microscopy and Cell Biology, Tata McGraw-Hill Publishing Company Limited, New Delhi.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE -19

Immunology: Understanding the body's defence Systems

Zoo-GE -19

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	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Immunology: Understanding the body's defence System **Zoo-GE-19**	04	02	Nil	02	XII Class	Nil	Zoology

Learning Objectives

The learning objectives of this course are to:

- Describe the general difference between the innate and the adaptive immune system.
- Broadly describe how the innate and the adaptive immune systems mature in the body, how they interact with each other, and how they function in protecting the host from infections.
- Impart an in-depth knowledge on how our immune system fights with infection and foreign substances that can harm our body.
- acquire knowledge of the immunogenicity of biomolecules.

Learning Outcomes

By studying this course, students will be able to:

- Have an in-depth understanding of the innate and the adaptive immune system.
- Gain experimental skills and techniques frequently used in research in immunology.
- Develop essential skills in experimental design, techniques and execution, which are relevant to immunology.

- Comprehend and analyze the different cellular and humoral components of the immune system.
- Appreciate the contribution of various components of immune system in health and disease including basis of vaccination, autoimmunity, immunodeficiency and hypersensitivity

SYLLABUS

THEORY **(30 hrs)**

UNIT- 1: Basics of Immunology **5 hrs**

History and scope of immunology; Types of immunity: innate and adaptive, Humoral and cell-mediated immunity, Active and Passive immunity; Cells and organs of the immune system, overview of Haematopoiesis.

UNIT- 2: Antigens and Antibodies **7 hrs**

Antigenicity, immunogenicity; Structure and types of antibodies; Antigen-antibody interactions (agglutination, precipitation); Monoclonal antibodies production and their therapeutic applications.

UNIT- 3: Immune Response and Mechanisms **5 hrs**

Major Histocompatibility Complex (MHC I & II); Exogenous and endogenous antigen processing; overview of Cytokines and complement system.

UNIT- 4: Immunological Disorders and Applied Immunology **13 hrs**

Hypersensitivity reactions (Gell and Coomb's classification); Autoimmunity and autoimmune diseases (e.g., rheumatoid arthritis, thyroiditis); Immunodeficiency (e.g., SCID, AIDS. Vaccines and immunization programs; Principles of immunodiagnostics (ELISA, RIA, Western blot); Basics of Immunotherapy; Transplantation

PRACTICALS **(60 hrs)**
(Laboratory periods: 15 classes of 4 hours each)

1. Study of lymphoid cells and organs in rat/mouse*.
2. Identification of different blood cells using Leishman's/Giemsa/Crystal violet stained blood smear.
3. Blood group determination by ABO kit.
4. Cell counting and viability test (trypan blue dye exclusion test) from splenocytes from rat/mouse/any other species.
5. To understand the antigen and antibody interactions by:

i) Ouchterlony's double immunodiffusion method to study immunoprecipitation and interpretation of patterns of identity, non-identity and partial identity.
ii) Demonstration of ELISA.
iii) FACS

PROJECT WORK

Project on any topic/ Project report on visit to any research institute/laboratory to study the immunological techniques.

Essential/Recommended Readings

1. Owen, Punt, Stranford, Patricia Jones, Judy Owen (2018). Kuby Immunology (8th ed.). New York, WH: Freeman, ISBN: 978-1319114670
2. Kenneth Murphy, Casey Weaver (2016), Janeway's Immunobiology (9th ed.). Garland Science, ISBN: 978-0815345053
3. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006) Immunology, VI; Edition, W.H. Freeman and Company.
4. Abul Abbas, Andrew Lichtman, Shiv Pillai (2017). Cellular and Molecular Immunology; Elsevier
5. David, M., Jonathan, B., David, R. B. and Ivan, R. (2006) Immunology, VII Edition, Mosby, Elsevier Publication.

Suggested Readings

1. Peter Parham (2020) The immune System .(5th ed.). Garland Science, ISBN: 978-1285776902
2. Ivan Roitt, Ivan Roitt, and R. M. Hay (2016) Immunology (9th Edition) Blackwell Science.
3. Singh, I. K. and Sharma, P. [Eds.] (2022) An Interplay of Cellular and Molecular Components of Immunology. Taylor & Francis group, CRC Press.
4. Singh, I. K. and Sharma, P. [Eds.] (2022) Essentials of Immunology, Laboratory Manual; Prestige Publishers.
5. Kaur, H., Toteja, R., and Makhija, S. (2021) Textbook of Immunology, I.K International Publishing House and Wiley India Ltd.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE-20

Concepts of Human Metabolism

Zoo-GE -20

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	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Concepts of Human Metabolism **Zoo-GE-20**	04	02	Nil	02	XII Class	Nil	Zoology

Learning Objectives

The learning objectives of this course are to:

- Understand the concepts of various metabolic pathways.
- Obtain knowledge of the tissue metabolism and its regulation.
- Become conversant with the idea of enzyme specificity in metabolic pathways
- Learn how the body adjusts to variations in the demand for energy.

Learning Outcomes

By studying this course, students will be able to:

- Comprehend the fundamental concepts of metabolism.
- Better appreciate the importance and functions of carbohydrates, lipids, proteins in human metabolism.
- Comprehend the concept and mechanism of enzyme action and its regulation.
- Appreciate the importance of high energy compounds, electron transport chain, synthesis of ATP under aerobic and anaerobic conditions.

SYLLABUS

THEORY **(30 hrs)**

UNIT- 1: Overview of Metabolism **4 hrs**

Concept of metabolism: anabolism and catabolism, general introduction of metabolic pathways; Regulation of metabolism (enzymatic and hormonal), compartmentalization of metabolism, Overview of digestion and absorption of carbohydrates, lipids and proteins.

UNIT- 2: Metabolism of Biomolecules: 21 hrs

Carbohydrates: Glycolysis, Citric acid cycle, Gluconeogenesis, Hexose Monophosphate pathway, Glycogen metabolism. **Lipids**: Beta oxidation of fatty acids, Metabolism of Ketone bodies, Metabolism during starvation. **Proteins**: Concept of Ureotelism, Uricotelism and Ammonotelism, Transamination, Deamination, Nitrogen metabolism, Ketogenic and glucogenic amino acids.

UNIT- 3: Electron transport System 3 hrs

Biological Redox systems; Overview of mitochondrial respiratory chain: electron carriers.

UNIT- 4: ATP Synthesis 2 hrs

Sites of ATP production, ATP synthesis- Oxidative phosphorylation and Substrate-level phosphorylation; Chemiosmotic theory, Shuttle systems.

PRACTICALS (60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. To qualitatively identify the functional groups of carbohydrates
2. Estimation of total protein in given solutions by Lowry's method.
3. Separation of amino acids and lipids by chromatography.
4. Study the action of salivary amylase under optimum conditions.
5. To study biological oxidation using goat liver.

Essential/recommended readings

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.). New York, WH: Freeman.
2. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.), New York, WH: Freeman Company.

Suggested Readings

1. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.), New Jersey, John Wiley & Sons Asia Pvt. Ltd.
2. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry. XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.

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SEMESTER – VIII

List of GE Papers

Course Title	Nature of the Course	Total Credits	Components			Page No.
			Lectures	Tutorial	Practical	
Neurobiology	Zoo-GE-21	4	2	Nil	2	44
Classical and Molecular Cytogenetics	Zoo- GE- 22	4	2	Nil	2	48
Concepts of Evolutionary Ecology	Zoo-GE-23	4	2	Nil	2	51

GENERIC ELECTIVE COURSE -21

Zoo-GE -21

Neurobiology

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	Department offering the course
		Lectures	Tutorial	Practical / Practice			
Neurobiology **Zoo-GE-21**	04	02	Nil	02	XII Class	Nil	Zoology

Learning Objectives

The learning objectives of this course are to:

- Understand the fundamental structure and function of the nervous system.
- Explore key concepts in Neurobiology in relation to non-zoology disciplines.
- Analyze the relationship between neurobiology and other areas of study.
- Develop critical thinking skills in evaluating neurobiological principles.

Learning Outcomes

By studying this course, students will be able to:

- Comprehend the structure and function of the nervous system, including neurons, glial cells, and synaptic transmission.
- Apply knowledge of neurophysiology, including action potentials, membrane potentials, and sensory-motor systems.
- Analyze the relationship between basic principles of neurophysiology and higher brain functions such as learning, memory, and behaviour.
- Identify and discuss common neurological disorders and their underlying neurobiological mechanisms.
- Evaluate interdisciplinary applications of neurobiology in fields such as psychology, medicine, and technology.
- Develop critical thinking skills through discussions, assignments, and examinations, fostering an understanding of neurobiological principles applicable to non-zoology disciplines.

SYLLABUS

THEORY (30 hrs)

UNIT 1: Introduction to Neurobiology and Neurophysiology 6 hrs

Overview of the nervous system and its subdivisions; Structural and functional differences between Neurons and Neuroglial cells; Composition and role of CSF, Blood-Brain barrier. Excitability of Neurons; Ion channels and membrane potentials, Generation of Action potentials. Excitatory and Inhibitory post-synaptic potential.

UNIT 2: Neuronal Communication 10 hrs

Types of Synapses, Receptors, and Neurotransmitters. Information processing by the nervous system: Sensory receptors and their types; Responses to key sensory stimuli/ impulses: Light (Vision), Smell (Olfactory), Auditory (Hearing), Touch (Tactile) and Taste (Gustatory).

UNIT 3: Higher Brain Functions 4 hrs

Brain regions and their specialized functions: Learning and Memory, Emotions and Behaviour. Overview of some Neurological Disorders (Alzheimer's, Parkinson's, Schizophrenia, etc.).

UNIT 4: Applications of Neurobiology 10 hrs

Applications of Neurobiology in Psychology, and Medicine: Neural mechanisms in maintenance of Circadian rhythms and their relationship to sleep-wake cycles; Sleep-related disorders: insomnia, sleep apnea, and shift work disorder; Role of sleep in mood regulation, stress (anxiety and depression) management; Mental wellness: Role of lifestyle, mindfulness, and early intervention; Advances in neuroscientific research: Brain imaging tools (EEG, fMRI, PET) Brain-Computer Interfaces (BCIs).

PRACTICALS (60 hrs)
(Laboratory periods: 15 classes of 4 hours each)

1. Microscopic examination of neuron structure using prepared slides.
2. Identification of different types of neurons (e.g., motor neurons, sensory neurons) and glial cells (e.g., astrocytes, oligodendrocytes) under the microscope.
3. Study of Anatomy of the Mammalian Brain (from slaughterhouse) or by using brain models (Plastic or clay anatomical teaching models, graphics, videos, etc. can be used).
4. Histological study of neurons and myelin sheath (Nissl and Luxol Fast Blue staining.)
5. Analysis of neurological and psychiatric disorders (e.g., Alzheimer's, Parkinson's, Schizophrenia) through clinical case vignettes and brain imaging.

Project on any one of the following topics:

1. Reaction Time and Sensory Coordination
2. Sleep Diary and Memory Recall Analysis
3. Case Study on Ethical Implications of BCIs or Neuro-prosthetics
4. Role of Brain Science in Advancing Artificial Intelligence

Essential/recommended readings:

- Mark F. Bear, Barry W. Connors, and Michael A. Paradiso (2015). Neuroscience: Exploring the Brain. IV Edition.
- Kandel, E.R., Schwartz, J.H. and Jessell, T.M. (2000). Principles of Neural Science. IV Edition, McGraw-Hill Companies.
- Kandel, E.R., Schwartz, J.H. and Jessell, T.M. (1995). Essentials of Neural Science and Behavior. I Edition, New York: McGraw-Hill

Suggested readings:

- Squire, L., Berg, D., Bloom, F. E., du-Lac, S., Ghosh, A., Spitzer, N. C. (2012). Fundamental Neuroscience, IV Edition, Academic Press Publications.
- Purves, D. et al., (2017) Neuroscience, VI Edition. Oxford University Press.
- Neuroethics: Defining the issues in THEORY, practice, and policy (2nd edn). Edited by Judy Illes
- Brain-Computer Interfaces: Principles and Practice (2012). Editors: Jonathan R. Wolpaw, Elizabeth Winter Wolpaw. Oxford University Press

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE -22

Classical and Molecular Cytogenetics

Zoo-GE -22

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	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Classical and Molecular Cytogenetics **Zoo-GE-22**	04	02	Nil	02	XII Class	Nil	Zoology

Learning Objectives

The learning objectives of this course are to:

- Understand the structure of chromosomes and its classification along with the condensation of DNA into chromosomes.
- Explore the transmission of the chromosomes from a generation to the next.
- Explain the organization and complexity of the human genome at the cytogenetic level.
- Investigate the nature of chromosomal abnormalities and related cytogenetic disorders.
- Evaluate appropriately the family pedigree and population and ethnic aspects of inherited disorders.
- Estimate the risk of recurrence of various inherited disorders in affected families.
- Acquire knowledge of the molecular cytogenetic tools which aid in prenatal diagnosis.

Learning Outcomes

By studying this course, students will be able to:

- Describe the condensation process of chromosomes along with their structural details.
- Have an in-depth understanding of chromosome transmission.
- Comprehend and analyze the factors leading to cytological disorders.
- Appreciate the role of genetic counselling in the prenatal stage.
- Develop essential skills for handling of cytogenetic tools such as FISH, PCR, and NSG used in genetic diagnostics.

SYLLABUS

THEORY **(30 hrs)**

UNIT- 1: Introduction to Cytogenetics **3 hrs**

Overview of cytogenetics and its historical development. Relationship between genetics, cytogenetics, and cytogenomics.

UNIT 2: Genomes and chromosomes **8 hrs**

Cell division: Mitosis, Meiosis, and the Cell Cycle. Sex chromosomes and their determination. Chromosome morphology and structure. Chromosomal aberrations and associated genetic diseases. Epigenetic mechanisms. Genomic analysis techniques.

UNIT- 3: Molecular Markers and Techniques in Cytogenetics **14 hrs**

Principles and applications of cytogenetic tools*: Karyotyping, FISH, CGH, DNA microarray, PCR, NGS, and CRISPR-Cas9. Basics of probe design and labelling. Emerging trends in the field. Microsatellites, Single nucleotide polymorphisms (SNPs), DNA sequencing techniques

UNIT- 4: Clinical Cytogenetics **5 hrs**

Genome instability and its role in cancers. Genetic counselling and Prenatal diagnosis.

PRACTICALS **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. Demonstration of cell culture techniques.
2. Study of Mitosis and Meiosis using permanent slides and squash techniques.
3. Chromosome staining methods: G-banding
3. Karyotype preparation and analysis of metaphase chromosomes for genetic disorders/abnormalities.
4. To study the methods, principles, and procedures of FISH
5. Demonstration of DNA microarray
6. To study applications of Next-generation sequencing (NGS) in cytogenetics
7. To perform Polymerase chain reaction (PCR) and Primer designing.

Essential/recommended readings

1. Textbook 1. Marilyn S. Arsham and Margaret J. Barch (2017) The AGT Cytogenetics Laboratory Manual, 4nd Edition.
2. J. McGowan-Jordan and A. Simons (2016) An International System for Human Cytogenomic Nomenclature Reprint of: Cytogenetic and Genome Research, Vol. 149, No. 1-2.
3. Rooney D.E., Czepulkowski B.H. (2001) Human Cytogeneitcs: A Practical Approach. Volume I og II, Oxford University Press.

4. Wolpert, L. (2002). Principles of Development. II Edition, Oxford University Press.

Suggested readings

1. Susan Mahler Zneimer (2014) Cytogenetic Abnormalities: Chromosomal, FISH, and Microarray Based Clinical Reporting and Interpretation of Result
2. Steven L. Gersen and Martha B. Keagle (2004) The Principles of Clinical Cytogenetics

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE-23

Concepts of Evolutionary Ecology

Zoo-GE -23

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	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Concepts of Evolutionary Ecology **Zoo-GE-23**	04	02	Nil	02	XII Class	Nil	Zoology

Learning Objectives

The learning objectives of this course are to:

- Explore the interface of ecological and evolutionary forces that lead to the diversity of the form.
- Understand the function, and behaviour among animals.
- Impart an understanding of the evolutionary origin and drivers of biological variation and diversity, including the significance of genetic variation, natural selection, and genetic drift.
- Unravel the evolution of animals, sexual selection, evolution of mating systems, animal interactions, reaction norms and plasticity.

Learning Outcomes

- By studying this course, students will be able to :
- Better understand the diverse relationships that the organisms have in the environment.
- Analyze the patterns of distribution of animals in different regions and ecosystems.
- Gain insight into the major events in history of life
- Know the fundamental concepts of natural selection, speciation, mass extinction and macro-evolution.
- Explain the characteristics, dynamics, and growth of populations.
- Appreciate the characteristics of the community, ecosystem development and climax theories.

- Gain knowledge about the relationship of evolution of various species and the environment they live in.

SYLLABUS

THEORY (30 hrs)

UNIT- 1: Overview of Evolutionary Ecology 5 hrs

Introduction to the relationship between evolution and ecology, Origin of life: chemogeny and endosymbiotic theory. Natural selection, adaptation and fitness. Ecological adaptations of animals to their environment.

UNIT- 2: Population Ecology 7 hrs

Density, mortality, natality, dispersal and dispersion, life tables, fecundity tables, survivorship curves, age and sex ratios. Population growth- exponential and logistic. Life history traits - r and K selection. Population regulation, positive and negative interactions.

UNIT- 3: Community Interactions 6 hrs

Community Characteristics: species richness, dominance, diversity and abundance. Organisation of community– habitat, niche, guilds, and dominant species. Interspecific interactions with examples. Species diversity indices. Categories of ecological succession. Climax community, Concept of keystone, flagship, umbrella species with examples.

UNIT- 4: Evolutionary Progressions, Concept of Species and Coevolution 12 hrs

Natural selection and its types, Genetic drift, Artificial selection. Species concept, Isolating mechanisms, Modes of speciation (Allopatric, Sympatric, Parapatric and Peripatric), Adaptive radiation/macroevolution (Darwin's finches). Forms of coevolution (pairwise coevolution, diffuse coevolution, and gene-for-gene coevolution); Co-evolutionary interactions (Coevolution of competitors, Predator-prey coevolution, Host-parasite coevolution, Coevolution of mutualists); Evolutionary equilibria. Co-speciation and diversification.

PRACTICALS (60 hrs)
(Laboratory periods: 15 classes of 4 hours each)

1. Study of an aquatic ecosystem- phytoplankton and zooplankton: Sample collection of specimens from an ecosystem (pond/river/lake/forest/garden) to study its biotic components.
2. Estimation of turbidity/penetration of light, temperature, Dissolved Oxygen content (Winkler's method), determination of pH.
3. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.

4. Plotting of different types of survivorship curves from the provided life tables of the hypothetical/real data.
5. Understanding the homology, analogy and homoplasy from suitable specimens.
6. Construction of cladograms based on morphological characters.
7. Study and verification of Hardy-Weinberg Law by Chi-square analysis

PROJECT WORK

Project report based on the visit to the natural history museum/National Park/Biodiversity Park/Wildlife Sanctuary.

Essential/recommended readings

1. Futuyma, Douglas and Mark, Kirkpatrick (2017) 3rd Ed. Evolutionary Biology, Oxford University Press
2. Hall, B.K. and Hallgrimson, B. (2013) Evolution; 5th Edition, Jones and Barlett Publishers.
3. Zimmer C. and Emlen D. J., (2013) 1st Ed. Evolution: Making Sense of Life, Roberts & Co.
4. Chapman, J., and Reiss, M. (2012). Ecology Principles and Applications; Cambridge University Press.
5. Odum, E. P. and Barrette, G. W. (2008) Fundamentals of Ecology; 5th Indian edition; Brooks/Cole
6. Miller, T., and Spoolman, S. (2008) 12th Edition Environmental Science- Problems, Concepts and Solutions; Thomson Brooks/Cole.

Suggested readings

1. Smith T. M. and Smith R. L. (2015). Elements of Ecology. 9th International Edition. Publisher: Benjamin Cummings.
2. Ridley, M. (2004). Evolution. III Edition, Blackwell publishing.
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NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.