

2019
DEPARTMENT OF ZOOLOGY
BODOLAND UNIVERSITY
1ST SEMESTER SYLLABUS



2019
NEW STRUCTURE
M.Sc. ZOOLOGY SYLLABUS
BODOLAND UNIVERSITY

SEMESTER - 1

Subject		Credit	Credits (L+T+P)	Marks (Internal + Final)
ZOO-101	Ecology and Environmental Biology	4	(3+1+0)	20+80=100
ZOO-102	Cell Structure and Function	4	(3+1+0)	20+80=100
ZOO-103	Endocrinology	4	(3+1+0)	20+80=100
ZOO-104	Evolutionary Biology and Biosystematics	4	(3+1+0)	20+80=100
ZOO-105	Practical	5	(0+0+5)	20+80=100
Open Elective ZOO-106-OE1 ZOO-106-OE2	OE1- Sericulture OE2- Apiculture	2	(2+0+0)	10+40=50
		23		550

(Theory/Tutorial)

1 credit = 15 contact hrs per semester

18 credits = 15 x 18 = 270 contact hrs per semester

(Practical)

1 credit = 2 Hrs = 2 x 15 = 30 contact hrs

5 credit = 30 x 5 = 150 contact hrs per semester

Total = 270+150 = 420 contact hrs per semester

SEMESTER – 2

Subject	Credit	Credits (L+T+P)	Marks (Internal + Final)	
ZOO-201	4	(3+1+0)	20+80=100	
ZOO-202	4	(3+1+0)	20+80=100	
ZOO-203	4	(3+1+0)	20+80=100	
ZOO-204	4	(3+1+0)	20+80=100	
ZOO-205 (P)	5	(0+0+5)	20+80=100	
Open Elective ZOO-206-OE1	2	(2+0+0)	50	
Total	23		550	

(Theory/Tutorial)

1 credit = 15 contact hrs per semester

18 credits = $15 \times 18 = 270$ contact hrs per semester

(Practical)

1 credit = 2 Hrs = $2 \times 15 = 30$ contact hrs

5 credit = $30 \times 5 = 150$ contact hrs per semester

Total = $270+150 = 420$ contact hrs per semester

SEMESTER- 3

Subject	Credit	Credit (L+T+P)	Marks (Internal + Final)	
ZOO-301	4	(3+1+0)	20+80=100	
ZOO-302	4	(3+1+0)	20+80=100	
ZOO-303	4	(3+1+0)	20+80=100	
ZOO-304	4	(3+1+0)	20+80=100	
ZOO-305(P)	5	(0+0+5)	20+80=100	
Core Elective ZOO-306E1 ZOO-306E2	3	(2+1+0)	20+80=100	
	24		600	

(Theory/Tutorial)

1 credit = 15 contact hrs per semester

19 credits = 15 x 19 = 285 contact hrs per semester

(Practical)

1 credit = 2x15 = 30 contact hrs per semester

5 credit = 30 x 5 = 150 contact hrs per semester

Total = 285+150 = 435 contact hrs per semester

SEMESTER- 4

Subject	Credit	Credits (L+T+P)	Marks (Internal + Final)	
ZOO-401	4	(3+1+0)	20+80=100	
ZOO-402	4	(3+1+0)	20+80=100	
ZOO-403	4	(3+1+0)	20+80=100	
ZOO-404(P)	4	(0+0+4)	20+80=100	
ZOO-405 (Dissertation)	6	(0+0+6)	40+60=100	
	22		20+80=100	

(Theory/Tutorial)

1 credit = 15 contact hrs per semester

16 credits = 15 x 16 = 240 contact hrs per semester

(Dissertation & Practical)

1 credit = 2x15 = 30 contact hrs per semester

4 + 6 = 10 credit = 30 x 10 = 300 contact hrs per semester

Total = 240+300 = 420 contact hrs per semester

PAPER CODE: ZOO-101

ECOLOGY AND ENVIRONMENTAL BIOLOGY

4 CREDITS

UNIT- 1

16 lectures

Concepts of Ecology - Introduction to ecology, Organizational level of ecological systems, evolutionary ecology, environmental concepts-Abiotic and biotic environment, limiting factors, adaptation, aquatic and terrestrial ecosystem; Community ecology: community structure, species richness and evenness; keystone species concept, types of community changes, ecological succession- models, concept of climax; Ecosystem Bioenergetics: Tropical structure, food chain and food webs, energy flow, and Lindemann's trophic dynamics concepts, concept of productivity, energy flow through ecosystem, biogeochemical cycles. Climatic Changes & ecosystem: Niche and Climate Change, Species Range Shifts, Tree Line Shift to Pole Wards and Up Slopes, Pest's and Pathogen's Range Shifts, Coral Bleaching, Extinctions, Impact on Timings of Biological Events and clocks, Signaling Changes; The biosphere concept, biomes and impact of climate on biomes, major biomes of India and the world, Ecosystem destruction: factors and management.

UNIT- 2

14 lectures

Population ecology: Characteristics of population, population parameters, and structure, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure. Growth regulation, life tables & survivorship curve, density dependent & independent factors, Life history strategies-K or r selection, Age and Sex ratio, the concept of carrying capacity, interactions between populations. Logistic model of population growth, territoriality
Species interaction: intra-and inter-specific interactions, Niche concept, ecological niche, niche overlap and separation; Competition and coexistence, scramble and contest competition model, mutualism and commensalism, prey-predator interactions, Lotka-Volterra Model, competitive exclusion principle

UNIT- 3

11 lectures

Biodiversity and its Conservation: concepts, significance, magnitude and distribution; Biodiversity indices, Threats to biodiversity, IUCN threat categories, Red data book; threat to Wild Life; in-situ and ex-situ conservation strategies, habitat Conservation, acceleration of ecological succession, reintroduction of biota; Megadiversity zones and Hot spots. Captive Breeding, Development of Biological Reserves, National Parks, Forest Reserves, Wild Life Refuges and Biosphere Reserves. Legal Actions, Public Participation and Awareness, Traditional and Modern Approaches Used In India for Conservation. Project Tiger, Chipko Movement, Appiko Movement, Indian Biosphere Reserve Programme.

UNIT- 4

11 lectures

Environmental Pollution and its management: Air, water, soil; Pollutants: types and major sources, effects on physico-chemical and biological properties of surrounding atmosphere, water, soil; effects on human health; Noise pollution: major sources, permissible noise level standard. Radioactive and thermal pollution sources and their effects; Solid waste disposal and its effects on surrounding environment; Solid Waste management: Degradation, Composting. Infectious and Medical Waste Pollution and Management; Concepts of sustainable development: social environmental issues and urban problems related to energy, industrial ecology and recycling industry; Eco-marketing.

UNIT- 5

08 lectures

Environmental Legislation: Central and state Pollution boards: powers and functions. Wildlife Protection Act 1972, The Water (Prevention and Control of Pollution) Act 1974. Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981, Environment (protection) Act 1986, Hazardous waste (Management and Handling) Rules, 1989, Bio-Medical Waste (Management and Handling) Rules, 1998; Duties and responsibilities of citizens for environmental protection; Environmental Impact Assessment

(EIA) international organization for standardization (ISO); Role of information technology in environmental conservation, current environmental issues in India and environmental ethics.

RECOMMENDED BOOKS

1. Elements of Ecology, Thomas M. Smith, Robert Leo Smith, 9th Edition. Pearson Education Publishers
2. Fundamentals of ecology, Eugene Odum, Garry W. Barret. Brooks/Cole;
3. Field Sampling: Principles and Practices in Environmental Analysis, Conklin, A.R. Jr., (2004), CRC Press.
4. Principles and Standards for Measuring Primary Production, Fahey, T.J. and Knapp, A.K., (2007), Oxford University Press, UK
5. Ecological Modeling, Grant, W.E. and Swannack, T.M., (2008), Blackwell.
6. Fundamental Processes in Ecology: An Earth system Approach, Wilkinson, D.M., (2007), Oxford University Press, UK.

PAPER CODE: ZOO-102

CELL STRUCTURE AND FUNCTION

4 CREDITS

UNIT – 1

10 lectures

Cell organization: Cell classification, cell variability (size, shape, complexity, functions), Prokaryotes - origin and evolution of metabolism, Viruses - structure and replication, Bacteriophage (Lambda phage, phi x 174), Animal DNA virus (SV 40), Retroviruses (HIV), Bacteria- Structure and reproduction of E. coli, Plasmid and their functions; Eukaryotes – origin of eukaryotes, development of multicellular eukaryotes; cells as experimental models

UNIT - 2

14 lectures

Cell Membrane and transport System: Models of cell membrane, fluid mosaic model of membrane, composition and organization of lipid bilayer and membrane proteins, fluidity of cell membrane; Transport across cell membrane – Channels and transporters, Diffusion, osmosis and measurement of osmotic pressure; ionic concentration and membrane potential; Active transport and ion transports- types, ATP powered pumps, Co-transport by symporters and antiporters; transcellular transport

UNIT - 3

14 lectures

Membrane Targeting and sorting of proteins: Signal peptide and SRP dependent targeting of translational complex; Processing of proteins in RER; Protein Modifications, Folding, and Quality Control in the ER; Processing through Golgi complex: targeting to plasma membrane and lysosome; Targeting of proteins to mitochondria and chloroplast; Secretory pathways – vesicle budding and fusion, stages of secretory pathway

UNIT - 4

08 lectures

Nucleus and nucleolus: Structure and organization of nucleus - nuclear membrane, nuclear lamina and nuclear pore complex – structure and function, organization of nuclear membrane during cell division, chromosome territory inside nucleus, selective transport of molecules into and out of the Nucleus; Nucleoskeleton and nuclear matrix; Nucleolus and its structure, Assembly and biogenesis of ribosomes

UNIT - 5

14 lectures

Cell signaling system – signal transduction and signaling molecules; types of receptors - nuclear receptors, membrane receptors (enzyme linked receptors, Ion channel receptors), Miscellaneous receptors (Toll like receptors TLR); Signal transduction: G-protein mediated signaling pathway, cytokine receptor – JAK/STAT, MAPK, Ras/Raf signaling pathway, receptor tyrosine kinase – sub-families, phosphatidylinositol signaling pathways, ubiquitinylation signaling pathways, signal amplification, Second messenger systems in cellular signaling

RECOMMENDED BOOKS

1. Lodish et al: Molecular Cell Biology. 8th edition 2016, W. H. Freeman and Company
2. Alberts et al: Molecular Biology of the Cell. 5th edition, 2008, Garland Science
3. Cooper and Hausman: The Cell. 4th edition, 2007; Sinauer Associates, USA
4. Lynne Cassimeris et al.: Lewin's cells. 3rd edition, 2015. Jones & Bartlett Learning, USA

PAPER CODE: ZOO-103

ENDOCRINOLOGY

4 CREDITS

UNIT - 1

12 lectures

Hormones: Chemical nature and classification of hormones, endocrine, paracrine and autocrine hormones; hormone receptors and target organs; Hormones as 2nd messengers, molecular basis of hormone action, structure and signal transduction mechanisms (steroid and peptide hormones); Hormonal regulation of ovulation, gestation, parturition and lactation, Hormonal regulation of spermatogenesis, Endocrine control of osmoregulation in fish

UNIT - 2

10 lectures

Endocrine physiology in vertebrates: Pituitary, thyroid, parathyroid, adrenal and pancreas, hormones of islets of langerhans and their functions, insulin and glucagon in carbohydrate metabolism, calcium regulating hormones, Biosynthesis of Insulin, T3 and T4, adrenal cortical and medullary hormones, their metabolic functions and metabolism.

UNIT - 3

12 lectures

Neuroendocrine systems in vertebrates, Tropic hormones and their feedback system and response to various stimuli (Tolerance to temperature, stress ,osmotic regulation etc); Endocrine drugs : Clinical Pharmacology of oxytocin, PRL, ADH, Insulin, GH, ACTH, Pharmacokinetics of hormones, Pathophysiology-pituitary dwarfism, gigantism and acromegaly ,Graves disease

UNIT - 4

12 lectures

Prostaglandins: Source, chemical nature, structure, functions, physiological significance and clinical implications,Pineal gland-structure and functions, diurnal variations of biosynthetic components of pineal gland, gastrointestinal hormones and their regulation and functions.

UNIT- 5

14 lectures

Neuroendocrine system of Insect: Neurosecretory cells of brain, neurohemal organs, Hormones produced by Neurosecretory cells and their functions: Prothoracicotropic hormone, Allatotropin, Allastanin, Diapause hormone, Bursicon, Eclosin hormone, Proctolin, Diuretic hormone and Heart beat accelerating factor. Chemical structure and function of JH, JH as a gonadotropin, Prothoracic gland and ring gland, Role of Juvenile hormone analogues and ecdysteroids in pest control, Pheromones: Classification, chemical nature, structure, functions, clinical applications

RECOMMENDED BOOKS:

1. Hadley: Endocrinology, Prentice hall. International Edition. 2000
2. Norris: Vertebrate Endocrinology (2nd Edition) Lea & Febriger. 1997.
3. Text book of Medical Physiology 11th Edition. By C. Guyton, M.DJohn E. Hall (2006)
4. Mammalian Endocrinology (4th edition), NCBA, by Ashoke kumar Boral (2011)
5. Insect Physiology and Biochemistry, 3rd Edition by James L. Florida, U.S.A. (2015)

PAPER CODE: ZOO-104

EVOLUTIONARY BIOLOGY AND BIOSYSTEMATICS

4 CREDITS

UNIT - 1

12 lectures

Evolutionary time scale and geological eras; Concept and theories of evolution; pre-biotic molecules and origin of life; evolution of prokaryotic and eukaryotic cells; evolution of cell organelles and genome; factors and forces of evolution - mutation, genetic variation, genetic drift and migration; Mendelian population – allele frequencies and genotype frequencies, Hardy-Weinberg equilibrium and conditions for its maintenance; the founder principle; bottleneck effect of genetic drift

UNIT - 2

12 lectures

Isolating and selection mechanisms: Classification of isolation – geographic isolation and reproductive isolation; pre-mating isolation – climatic, seasonal, habitat, ethological; Post-mating isolation – gametic mortality, zygotic mortality, Hybrid inviability, Hybrid sterility, Hybrid breakdown; Inbreeding and Heterosis; Selection – stabilizing, dispersive, frequency dependent and balancing selection

UNIT - 3

12 lectures

Origin and diversification of eukaryotes - origin of cells and first organisms; early fossilized cells; evolution of eukaryotic cell from prokaryotes - a symbiosis; evolution of eukaryotic genomes; gene duplication and divergence; Polymorphism in natural population - Chromosomal, DNA and alloenzyme polymorphism; genetic polymorphism; balanced polymorphism; Adaptive radiation; Biochemical evolution: metabolic pattern changes (autotrophic, heterotrophic, anaerobic and aerobic).

UNIT - 4

12 lectures

Speciation – mode of speciation; concept of speciation; factors responsible for speciation; tempo of evolution; Systematics - definition and role in biology; biological classification - theories and objectives, types of taxonomy; taxonomic diversity- definition and types; taxonomic characters; origination and extinction; rates of change in origination and extinction; causes of extinction; causes of differential rates of diversification; human evolution – history of human evolutionary, Evolution of anthropoid primates; placing humans on tree of life; genomics and humanness; current issues in human evolution.

UNIT - 5

12 lectures

The universal common ancestor and tree of life, three domain concept of living kingdom; molecular phylogeny – history, terms, definition and limitations, Molecular taxonomy and barcoding; construction of phylogenetic trees by using rRNA, ITS and COI gene sequences; molecular divergence and molecular clocks; Concept of neutral theory; origin of genomes by horizontal gene transfer; role of plasmid, transposons, integrons and genomic islands in DNA transfer; life and RNA world.

RECOMMENDED BOOKS

- 1) Futuyma DJ. (2009) Evolution. Publisher Sinauer Associates is an imprint of Oxford University Press; 4th edition.
- 2) Dobzhansky Th., FJ. Ayala, GL. Stebbins and JM. Balentine (1976) Evolution. Surjeet Publication, Delhi
- 3) Smith JM. (1998) Evolutionary Genetics. Oxford University Press. Oxford.
- 4) Rastogi VB. (2016) Organic Evolution. Publisher – MedTech, India
- 5) Stearns SC. and RF. Hoekstra (2000) Evolution: An Introduction. Oxford University Press, Oxford.
- 6) Strickberger MW. (1990) Evolution. Jones and Bartlett Publishers. Boston

OPEN ELECTIVE

PAPER CODE: ZOO-106-OE1

SERICULTURE

2 CREDITS

UNIT – 1

10 lectures

Introduction: Origin and history of Sericulture-Silk road

Sericulture map of India and World-Component of Sericulture

Sericulture practices in tropical and temperate climate

Classification and Characteristic features of sericigenous insect

Life cycle: Morphology of egg, larvae, pupa and adult, Host plants: Types, cultivation and maintenance;

Chawki garden- importance and maintenance

Rearing of Silkworm: Selection of silkworm breeds/races-Rearing house models, Rearing appliances, disinfection procedure, Chawki rearing

UNIT – 2

20 lectures

Diseases: Types, occurrence, symptoms, etiology and preventive measures

Pest and predator of silkworms: types, prevention and control

Silkworm seed production: Organization, Legislation Act, Grainages, sex separation and synchronization

Silk Technology: cocoon processing-physical, chemical and biological properties, Degumming, Spinning / reeling

Value added products, by-products and technology, Silk dyeing-natural artificial

Employment generation sericulture-Role of women in Sericulture

RECOMMENDED BOOKS:

- 1) F.A.O. (1984). Manual on Sericulture published by Food and Agriculture Organization
- 2) S.B. Dandin, J. Jayaswal and K. Giridhar (2001). Handbook of Sericulture Technologies. Publisher- Central Silk Board, Bangalore.
- 3) Muga Culture. 2013. Author: RN Singh, CM Vaspayi, A. Tikader and B. Sarat Chandra. Publisher – APH Publishing Corporation, New Delhi.
- 4) Sericulture- A comprehensive Profile. Authors: MC Sarmah, BN Sarkar, SA Ahmed and J Dewry. 2013. Directorate of Sericulture, BTC
- 5) Silkworm Egg Production. 1997. Publisher – Oxford and IBH Publishing Co. Pvt. Lt.

PAPER CODE: ZOO-105

PRACTICAL

5 CREDITS

- 1) Preparation of Mitotic chromosomes.
- 2) Karyotyping of chromosome
- 3) Study of Barr body in human using buccal smear
- 4) Isolation of genomic DNA from blood/tissue
- 5) Demonstration of Agarose gel electrophoresis
- 6) Physico-chemical properties of soil and water (Dissolved Oxygen, Free Carbon dioxide, alkalinity, Hardness, sulphate)
- 7) Assessing influence of light, temperature and moisture on plant germination and growth/animal behaviour and growth.
- 8) Assessment of density, frequency and abundance of plants/animal in a community using various techniques i.e. transect, quadrat etc.
- 9) Understanding ecosystem succession by studying various stages of vegetation / community assemblages development.
- 10) Insect diversity in soil.
- 11) Identification of aquatic organisms of different trophic levels and construction of food chain and food web.
- 12) Study of Ecological apparatus and their applications
- 13) Demonstration of endocrine organs in vertebrates.
- 14) Neuroendocrine system of cockroach - Dissection and display
- 15) Prothoracic gland of cockroach - Dissection and display and mounting
- 16) Thyroid and parathyroid gland of mouse/chicken - dissection and display
- 17) Pituitary gland of mouse/fish - Dissection and display
- 18) Histological study of pituitary, adrenal, testis, ovary, corpus luteum, pancreas and thyroid gland (Permanent slide)
- 19) Histology of ovary/accessory glands/corpus allatum/brain in insects
- 20) Pattern of evolution from museum specimen
- 21) Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test
- 22) Evolutionary significance of Isozyme analysis
- 23) Construction of molecular of phylogenetic tree using ITS/COI/rRNA
- 24) Study of population genetics problems
- 25) Taxonomic Study: Insect spider model, Fish Model

PAPER CODE – ZOO-201
REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY
4 CREDITS

UNIT-1 12 lectures

Ovarian and testicular physiology: Folliculogenesis and their control mechanisms, steroidogenesis and its hormonal regulation, menstrual cycle and its regulation, Female reproductive disorder, estrus cycle and its regulation, sertoli cell: structure and function; function of leydig cell.

UNIT-2 12 lectures

Fertilization- pre and post fertilization events: spermatogenesis and oogenesis, Structure of mammalian gametes mammals, Mechanism of implantation, organogenesis, Capacitation, Signal transduction pathway in acrosome reaction,placental hormones and their functions in mammals, Prevention of Polyspermy,contraception: hormonal and immune-contraception.

UNIT-3 12 lectures

Cell specification: The developmental dynamics of the cell specification, Cell commitment and differentiation, Development of gonads, totipotency and pluripotency, stem cells: Embryonic stem cells and adult stem cells, Haemopoietic stem cells : Blood cells formation, stem cell disorders and modes of cell type specification and their characteristics.

UNIT-4 12 lectures

Morphogenesis and cell adhesion molecules, Concept of morphogen gradients, role of paracrine factors in development, Hormonal control of amphibian metamorphosis, Embryonic induction, formation of organ rudiments and nucleo-cytoplasmic interaction in development.

UNIT-5 12 lectures

Introduction to assisted reproduction technologies: IVF, ICSI, GIFT and ZIFT, Teratogenesis and its principle, Teratogens and its effect in development,Contribution of teratology to developmental biology, Role of maternal contribution in early embryonic development in droshopila: maternal effect genes and zygotic genes, vulva formation in *Caenorhaptids elegans*, homeotic genes, and hox genes in development

RECOMMENDED BOOKS

1. Gilbert F. Scott, Developmental Biology, (9th Edition), 2010 (Sinauer Associates), Sunderland, Massachusetts, USA.
2. Arora. P, Mohan and Arora, Himanshu, Embryology, 5th edition, 2017. Himalaya Publishing House.
3. Bruce A. White, Susan P. Porterfield, Endocrine and Reproductive Physiology, (4th edition), 2013, ISBN: 978-0-323-08704-9, Elsevier (MOSBY).
4. Arhtur. C. Guyton and John E. Hall, Textbook of Medical Physiology, (12th edition), 2006, Elsevier (Saunders) ISBN: 978-1-4160-4574-8.
5. E. Hadley, Mac , Levine. E, Endocrinology, International Edition. 2007 ISBN: 0131876066, 9780131876064 (Prentice hall).
6. Kumar Boral, Ashok, Mammalian endocrinology (4th edition), NCBA.

PAPER CODE: ZOO-202
GENES AND GENOMICS
4 CREDITS

UNIT 1: 12 Lectures
Structure and Organization genome – Nucleic acids as genetic material; DNA vs. RNA as genetic material; concept of gene and gene families; non-coding genes; concept of intron; C-value paradox, Secondary structure of DNA and conformational flexibilities, Unusual secondary structure of DNA; Interrupted genes and their evolution; Repetitive DNA; Tertiary structure and super-coiling of DNA; DNA packaging – nucleosome and higher order structure of chromatin, virus and bacterial genomes; organelle genome - mitochondrial genome and chloroplast DNA; RNA based genomes; Chromatin structure regulation.

UNIT 2: 12 Lectures
DNA replication, recombination and repair – General features of prokaryotes and eukaryotes replication; Directions and types of replication; Stahl and Meselson experiment; Enzymes of DNA replication; energetic of nucleic acid polymerization; accuracy during flow of genetic information; proof-reading activity; replication in mt and ct-DNAs; telomere maintenance, telomerase and aging; DNA damage and Errors; types of DNA repair mechanisms; cellular response to DNA damage, Double strand break repairs.

UNIT 3: 12 Lectures
Transcription process - Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Antitermination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, and gal operons; Transcriptional control in lambda phage; Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase - I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TBP and TAF; Activators and repressors.

UNIT 4: 12 Lectures
Post-Transcriptional Processing - Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; splicing Mechanisms; Trans splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA; Transcriptional and post-transcriptional gene silencing by microRNA.

UNIT 5: 12 Lectures
Translation and transport - Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation.

RECOMMENDED BOOKS

1. Watson et al. 2014. Molecular Biology of the Gene, 7th edition
2. Lizabeth A. Allison et al. 2007. Fundamental Molecular Biology. 1st edition
3. T.A. Brown. 2007. Genome 3. 3rd edition
4. Robert F. Weaver. 2012. Molecular Biology. 5th Edition.
5. Jocelyn E. Krebs et al. 2014. Lewin's GENES XI. 11th edition

PAPER CODE: ZOO-203

BIOCHEMISTRY AND METABOLISM

4 CREDITS

UNIT-1

10 lectures

Protein structure and functions: Classification and structural features of amino acids; Peptides and peptide bonds; primary and higher order structures of proteins; Protein denaturation and Folding; Protein Structure and function (ribonuclease A, myoglobin, etc).

UNIT-2

12 lectures

Sugars and lipids: General characteristics; mono, polysaccharides and Glycoproteins: structure and functional significance - cellular structure, energy storage, signaling; Glycosylation and its importance; lipid – structure and properties of important members of storage and membrane lipids; lipoproteins.

UNIT-3

12 lectures

Enzymatic Catalysis – General properties of enzymes; principles of enzyme catalysis; enzyme kinetics and mechanism of enzyme action, Effect of substrate, pH, temperature; Michaelis-Menten kinetics; enzyme inhibition: types and mechanism; regulation of enzyme activity; Enzymes as drug targets.

UNIT-4

12 lectures

Bioenergetics: Principles of Bioenergetics, Equilibria, free energy; High energy compounds; Phosphoryl Group Transfers and ATP; Coupled reactions; Biological Oxidation-Reduction Reactions; Reducing power and Redox potential; Glycolytic pathways and rate limiting reactions; Kreb's cycle; Oxidative phosphorylation; electron transport chain; Fo-F1 ATP synthase

UNIT-5

14 lectures

Metabolism and its regulation: Overview of metabolism, metabolic flux, metabolism of primary metabolites – monosaccharides, lipids, essential amino acids and nucleotides. Mammalian fuel metabolism integration and regulation: Tissue-Specific Metabolism: The Division of Labour, Hormonal Regulation of Fuel Metabolism, metabolic homeostasis, metabolic disorders.

RECOMMENDED BOOKS

1. Lehningers Principles of Biochemistry, Nelson and Cox, Sixth Edition or recent edition, Macmillan Press.
2. Principles of Biochemistry, Voet, Voet and Pratt, 5th edition (2012) or recent edition, Wiley International Publications.
3. Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.
4. Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge [Latest edition]

PAPER CODE: ZOO-204
BIOINFORMATICS AND BIOSTATISTICS
4 CREDITS

Unit-1

12 Lectures

Introduction to bioinformatics; computational biology vs. bioinformatics; basics of genomics and proteomics; biological databases – protein and nucleic acid databases; correlation between databases; NCBI, EBI; BLAST and FASTA; File formats and its importance; Database submission; retrieval; relationship between sequence and biological functions; Sequence searching using BLAST and FASTA; Alignment of gene sequences; local and global alignment

Unit-2

12 Lectures

Analysis of DNA sequence: Finding and calculating core nucleotide sequence, Predicting ORFs; location of transcription start point and end point; getting polypeptide sequence of the extracted core nucleotide sequence; designing primers of specific gene; generation of restriction maps; Molecular Phylogenetic study using bioinformatics; Generating phylogenetic trees based on DNA sequence and evolutionary relationship.

Unit-3

12 Lectures

Analysis of proteins: Protein classification, Proteins-structure, folding and function studies; homology modeling, trading, prediction of protein structure (secondary and 3 dimensional), tools for structure prediction, validation and visualization; Computer assisted drug design- concept, methods and practical approaches, various computational methods applied to design the drugs: molecular docking; ligplot analysis; QSAR and 3DQSAR.

Unit-4

12 Lectures

Basic principles of Biostatistics - population, sample, variable, parameter, primary and secondary data; screening and representation of data - frequency distribution, tabulation, bar diagram, histograms, pie diagram, mean, median, mode, quartiles and percentiles; variance; standard deviation; standard error; coefficient of variation; Probability and distributions - definition of probability; independent events; Addition and multiplication rules, conditional probability.

Unit-5

12 Lectures

Regression analysis- Fitting of lines of regression, regression coefficient, coefficient of determination; hypothesis, critical region, and error probabilities, tests for proportion, equality of proportions, equality of means of normal populations when variances known and when variances are unknown: chi-square test for independence, P- value of the statistic, T-test analysis, confidence limits, introduction to one way and two-way analysis of variance.

RECOMMENDED BOOKS

1. Jin Xiong 2006. Essential Bioinformatics. 1st edition
2. Andreas D. Baxevanis and B. F. Francis Ouellette. 2001. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins. 2nd edition.
3. Pavel Pevzner and Rhon Shamir. 2011. Bioinformatics for Biologists. 1st edition.
- 4.

PAPER CODE: ZOO-206-OE1

AQUACULTURE

2 CREDITS

1. Aquatic Resources; Inland Water resources as an environment for aquatic communities, global water balance and research of aquatic resources, conservation and management of water resources for the use of aquatic communities, Classification of diversity of aquatic resources, Characteristic features of fresh water, brackish water and marine water environment, Origin and types of lake basins.
 2. Aquatic ecosystem (abiotic profile, different components, light attenuation characters and role of visible ray, thermal profile, salinity, ionic concentration, dissolved oxygen, carbon dioxide and nutrients; their role in maintenance of ecosystem; trophics state index.
 3. Aquatic biocoenosis; concept of aquatic communities, attributes of planktons, nektons, sestons, periphytons, benthos, macroinvertebrates and macrophytes; their role in aquatic biotopes, classification of plankton, seasonal and diurnal variation of planktons.
 4. Aquatic productivity: Principle, concept and measurement technique of primary and secondary productivity, classification of lakes based on productivity, ontogeny of Lake Environment; process and impact on biotopes.
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PAPER CODE: ZOO-206-OE2

PARASITE BIOLOGY

2 CREDITS

1. Introduction to parasitology; animal associations and host – parasite relationship; Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.
 2. Distribution of diseases and Zoonosis caused by animal parasites; neglected tropical diseases; morphology, lifecycle, mode of infection of *Plasmodium*, molecular biology of *Plasmodium* – drug targets, mechanism of drug resistance, vaccine strategies and proteomic approaches.
 3. Morphology, life-cycle, mode of infection of *Leishmania*, molecular biology of *Leishmania* – drug targets, drug resistance and vaccine strategies; Morphology, biology, life-cycle, mode of infection of *Entamoeba*, morphology, biology, life-cycles, mode of infection of *Giardia*; gastro-intestinal nematodes, morphology, biology, life-cycles, modes of entry of *Schistosoma*, *Wuchereria*, *Brugia*, *Ancylostoma*, *Trichinella* and *Dracanculus*.
 4. Molecular biology of nematodes, vaccine strategies, Immune response and self-defense mechanisms, immune evasion and biochemical adaptations of parasites; parasites of veterinary importance; Parasites of insects and their significance; morphology, biology, lifecycle and infection of crop plants by plant parasitic nematodes, plant parasitic nematodes, host parasite interactions, Chemotherapeutic targets in external covering and neuromuscular structures of helminth parasites.
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PAPER CODE: ZOO-205

PRACTICAL

5 CREDITS

1. Study of different types of eggs.
2. In vitro culture of chick embryo.
3. Study of developmental stages of frog/chick embryos from permanent slide.
4. Dissection of male/female reproductive system of cockroach/Grasshopper
5. Identification of invertebrates.
6. Identification of larval forms of invertebrates.
7. Study of chromosome banding techniques
8. Extraction of DNA from mammalian tissue
9. Extraction and detection of chromatin from mammalian tissue.
10. Spectrophotometric analysis of DNA
11. Spectrophotometric analysis of DNA
12. Preparation of solutions of different normality, molarity, and dilutions.
13. Preparation of a 'Good' buffer.
14. Estimation of protein by Lowry's method.
15. Enzyme assay of any one enzyme.
16. Physico-chemical or Kinetic characterization of enzyme.
17. Web-based tools for sequence searches and data mining
18. Downloading and visualizations of protein structures
19. Study of Ramachandran plot using 3D protein molecules.
20. Protein structure building and Protein Homology Modeling
21. Analysis and validation of protein structure using bioinformatics tools
22. Construction of phylogenetic trees for DNA and proteins.

THIRD SEMESTER

PAPER: ZOO-301: BIOLOGICAL TOOLS AND TECHNIQUES (4 CREDITS)

Unit-1

Microtomy and Microscopy: Basics of Microtomy - Tissue fixation, dehydration, clearing, infiltration, embedding for paraffin method, sectioning, mounting, staining - specific and differential staining; Eosin and Hematoxylin staining; Cryopreservation and Cryotomy; Histochemistry - principles and methodology; Microscopy – Basics of simple and compound microscopes, Types of microscopes - Simple, Compound, Confocal, Fluorescence, and Electron microscopes and their working principles; Flowcytometry - working principle.

Unit-2

Separation techniques: Centrifugation - principles and types of centrifugation, Low and high speed centrifuges, density gradient centrifugation, ultracentrifuge; Applications of centrifugation - preparative techniques, analytical measurements; care of Centrifuges and rotors; Chromatography – principles and types (paper chromatography, thin layer chromatography, gas chromatography, gel permeation chromatography, ion-exchange chromatography, high pressure liquid chromatography, affinity chromatography); Isolation of biomolecule using chromatography techniques, Separation of molecules using Soxhlet and Clevenger apparatus.

Unit-3

Tools for biological assays and electrophoresis: Basics of mole, molarity, and normality; Principle of colorimeter and spectrophotometer; Molecular analysis using UV/visible spectrophotometer; concept of blank solution and reference; preparation of solutions, buffers, and standard curves; concept of IC_{50} and LD_{50} ; Electrophoresis: types and working principles (Paper, PAGE, SDS-PAGE, Agarose gel electrophoresis, Pore gradient, 1D and 2D electrophoresis, Isoelectric Focusing); Staining and visualizations of gels (for both protein and nucleic acids); Troubleshooting in gel running

Unit-4:

PCR and Blotting techniques: Basics of nucleic acids and replication; Fidelity and processivity of enzymes; principles and types of PCR; PCR primer designing – specific and degenerate primers; Enzymes for PCR; Rolling cycle amplification; Blotting techniques – Southern, Northern, and Western Blot analysis; Basics of probes; DNA fingerprinting; Gel retardation assay; RNase protection assay; Hybridization techniques – FISH, GISH, and Colony hybridization.

Unit-5

Gene manipulation and sequencing techniques: Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; Gene replacement; Gene targeting and disruption; CRISPER method of gene editing; DNA sequencing – Enzymatic and Chemical basis, Automated DNA sequencing, RNA sequencing, Chemical Synthesis of oligonucleotide.

PAPER: ZOO-302: ANIMAL PHYSIOLOGY AND IMMUNOLOGY (THEORY) 4 CREDITS

UNIT I: Circulation and Respiration

Blood: Haemostasis, Haemoglobin: Role in oxygen and CO₂ transport, Oxygen dissociation curve and their physiological significance, Heart: Origin and conduction of cardiac impulse, cardiac cycle, ECG, Neurogenic and myogenic hearts, Respiratory centers: organization and function, Surfactant, Basal metabolic rate and its measurement, Respiratory adjustments, Hypoxia, Dyspnea, High altitude: decreased pressure of gas.

UNIT II : Muscle, Nutrition and Excretion

Ultra structure of skeletal muscle fibers: Proteins of the myofilaments, actin-myosin interaction, sarcoplasmic reticulum and role of calcium in contraction, energetics of muscle contraction.

Absorption of macronutrients, Gastrointestinal hormones and regulation, Obesity and starvation.

Tubular reabsorption and secretion, RAS and hormonal regulation of urine formation, Acid-base balance and homeostasis.

UNIT III: Nervous system, Vision and hearing

Axonal transmission: Motor neuron and other types of neurons, Synaptic transmission, Types of synapses and synaptic knobs, Excitatory and inhibitory post-synaptic potential, Chemical transmission, neurotransmitters.

Eye: Retinal components, Photoreceptors: Ionic basis of potential generation, Ear: Basilar membrane, and organ of Corti: Genesis of action potential in afferent nerve fibers.

UNIT IV: Overview of the immune system, structure and function of antibodies and MHC

Cells and organs of immune system, Components of the immune system, principles of innate and adaptive immunity, antigen and immunogenicity, antigen and its properties, super antigens, epitopes, antigen recognition by B and T- cells, clonal selection theory.

Antibodies: Major classes of antibody, structure and biological activities, antibody diversity, Class switching.

structure and function of MHC complex; antigen processing and presentation to T lymphocytes— antigen presenting cells, Innate Immunity— pattern recognition in the innate immune system, role of TLRs in innate immune response, complement system.

UNIT V: Effector mechanisms and regulation of immune responses, immunity in health and disease

Cell mediated and humoral immune response, production of effector T- cells, cytotoxic T- cell effector mechanisms; immunological memory.

Innate and adaptive immunity to infection, evasion of the immune response by pathogens; immunodeficiency diseases: inherited immunodeficiency diseases, acquired immune deficiency syndrome;

Allergy and hypersensitivity: IgE and hypersensitivity diseases; Tolerance and Autoimmunity: General features and mechanisms of immunologic tolerance, vaccines, transplantation rejection.

ZOO-303: GENETICS, CYTOGENETICS AND GENETIC ENGINEERING (THEORY) 4 CREDITS

Unit I: Cytogenetic

Chromatin Structure; Chromosome organization; Organelle genome organization: Origin and genome organization of mitochondria and chloroplast; Telomere; Centromere, Euchromatin and Heterochromatin, Karyotyping, Chromosome Banding, Chromosomal aberration/anomalies, mutation and cancer (CML, and Burkitt's Lymphoma).

Unit II: Principle of Genetics

Mendelism and its extension (multiple alleles, incomplete dominance, co-dominance, gene interactions, epistasis, pleiotropy, essential and lethal genes, gene action from genotype to phenotype- penetrance and expressivity), Chromosomal Theory of Heredity, Sex Linkage, Sex-limited, Sex-influenced Characters, Sex Determination, Dosage compensation, Mechanism and types of crossing over, Chromosome segregation and gene mapping; Epigenetic and Epigenetic inheritance.

Unit III: Population genetics

Genotype and allele frequency, Hardy-Weinberg's law of equilibrium, Factors affecting Hardy-Weinberg's law; Genetic Variation; Genetic hitchhiking; Role of genetics in conservational biology, Genetic basis of speciation.

Unit IV: Quantitative Genetics

Genetic analysis of complex traits - complex pattern of inheritance, Quantitative traits, Continuous traits, Threshold traits; Inbreeding, Heritability, Statistical method, Phylogeny, Response of Selection.

Unit V: Genetic Engineering

Restriction enzymes; DNA modifying enzymes; Linkers; Adaptors; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes; Cloning, expression cloning, identifying specified clones; Vectors; Transformation and Transfection techniques; Construction of libraries, cDNA and genomic libraries, jumping libraries; Isolation of mRNA and total RNA; Somatic and germ-line therapy- *in vivo* and *ex-vivo*; Y2H; Phage display; Transgenic.

PAPER ZOO-304:

Applied Entomology and Fishery (Theory)

4 CREDITS

Unit 1. Introduction to Entomology: Characteristics of class insecta, Classification of insects up to orders with Salient features and common examples. Morphological features and types of: Eyes, antennae, Mouth parts, Appendages. Social life in insects, Aquatic insects, Economic importance of insects, Food grain pests, Integrated Pest management. 10 h

Unit 2. Beneficial Insects: Parasitic and predatory insects and their role in weed management and pollination, insects as decomposers and their role in nutrient recycling. Life cycle, commercial culture, and commercial products of Honey Bee, Lac insect and Silkworm. 8 h

Unit 3. Medical Entomology: Insects as vectors of important diseases in Humans and animals. Insects Adaptation as vectors; Orders with insects as vectors (Diptera, Siphonaptera, Siphunculata, Hemiptera); External morphology, Life cycle, medical importance and control of *Anopheles*, *Aedes* and *Culex*; Phelbotomine sandly; Flea and Human louse (head, body and pubic louse) as disease vectors; Bugs as insect vectors; Blood sucking bugs; Chagas disease; Control and prevention methods. 12 h

Unit 4. Introduction to Fishery: General anatomy: Internal and External features; Basic osteology, Types of scales and fins, locomotion. Food and feeding habits of cultivable fishes; Feeding habits and habitat adaptations, Length-Weight Relationship and Condition Factor. Taxonomy and Classification of fishes. 8 h

Unit 5. Fisheries Resources of India: Status, diversity and distribution of freshwater fishes of India and Northeast India. Exotic food fishes of India-history, importance and impact to local environment, Ornamental fishes. Riverine fisheries- important river systems, dams and their impact, fish ladders. Cold water fisheries - ecology of hill streams, biology of important cold water fishes of India, recreational fishing. Estuarine fisheries- major estuarine systems of India. Marine fisheries – coastal and deep sea fisheries. 12 h

Unit 6. Fishing Technology, Management and Conservation: Fishing crafts and gears, Technologies for localizing catches- remote sensing, sonar, radar. Stock assessment and management - Natural and Applied markers- marking and tagging. Post harvest technology; Fish spoilage, rigor mortis, rancidity, enzymatic spoilage, microbial spoilage; Fish preservation and processing- principles and methods, fishery by-products. Methods of Genetic selection and hybridization of cultured species, Concept of cryopreservation and transgenic species, live gene bank and its importance in conservation. Fishing laws and regulations. Extension services. 10 h

References:

1. A general text book of entomology, Imms , A. D., Chapman & Hall, UK.
2. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M Saunders College Publication, USA
3. The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK.
4. Service, M.W. (1980) A Guide to Medical Entomology. Macmillan Press.
5. Fish and Fisheries of India. V.G. Jhingran. Hindustan Publishing Corporation, India.
6. The Physiology of Fishes. 2013. Evans, D. H. and Claiborne, J. D., Taylor and Francis
7. Handbook of Fisheries and Aquaculture. 2013. Indian Council of Agricultural Research, ICAR, DIPA, New Delhi, India. Group, CRC Press, UK.
8. Biology of Fishes. 2008. Bone, Q. and Moore, R., Talyor and Francis Group, CRC Press, U.K.

Open Elective-I

Nutrition, Health and Diseases

1. Introduction: Concept of food and nutrition, balanced diet, Nutritional status, malnutrition, nutrients composition, nutrient density and importance; Nutritional care, physiological, social and psychological functions of food. Human Energy System, Total Energy Requirement, Body Composition: Fatness and Leanness, Body mass index. 8 h
2. Nutritional Biochemistry: Nature, Classification, Importance, Functions, Recommended Intake and imbalance intake of Carbohydrates. Fiber - non digestible component of carbohydrate. Lipids - Physical and Chemical Nature, Fatty Acids - essential non-essential, MUFA, PUFA and Triglycerides, Food Lipids and Health, Lipid-Related Compounds. Proteins - Physical and Chemical Nature, amino acids, Functions of Protein, Protein and Nitrogen Balance, Protein Quality, Requirements and Intake. Digestion, absorption and metabolism of proteins, carbohydrates and lipids. Vitamins – Fat soluble, water soluble, Minerals and Trace elements. Water and electrolytes: requirements, forces controlling distribution, water balance and influencing factors, role of water in the body. 12 h
3. Nutritional Disorders: Definition, meaning and causes, Diabetes, Protein energy malnutrition, hypertension, hypervitaminosis and hypovitaminosis, Deficiency diseases of minerals and trace elements. Obesity - Meaning, Development of Obesity, Obesity as a Disease and its treatment. 10 h
4. Clinical nutrition and diet therapy: Role of Nutrition in Clinical Care, Nutritional requirements of newborn, young, adolescents, adults and pregnant mothers. Nutritional needs of patients undergoing treatment, injuries, surgeries; drug-nutrient interactions, nutritional assessment and requirements in diabetes, coronary heart and pulmonary diseases, renal diseases, AIDS, cancer, Alcoholism and its effects. 10 h

References and further readings:

1. Williams' Essentials of Nutrition and Diet Therapy. Eleanor D. Schlenker and Joyce Gilbert. 11th Edition. Gilbert Mosby, an imprint of Elsevier Inc. an affiliate of Elsevier Inc. ISBN: 978-0-323-18580-6.
2. Lippincott's Biochemistry Seventh Edition Denise R. Ferrier,
3. Fundamentals of Foods, Nutrition and Diet Therapy, Sumati R. Mudambi and M.V. Rajagopal. 5th Edition. New Age International (P) Ltd., Publishers, New Delhi-110002.
4. Vander et al.: Human Physiology: The Mechanism of Body Function, Eighth Edition, The McGraw–Hill Companies.
5. Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.

FOURTH SEMESTER

SPECIALISATION: MOLECULAR BIOLOGY AND IMMUNOLOGY

PAPER CODE: ZOO-401C: GENE MANIPULATION AND GENETIC ENGINEERING 4 CREDITS

Unit 1: Molecular Basis of Life

DNA, RNA and proteins, Molecular interactions in nucleic acids and proteins, molecular stability; Protein – structural hierarchy and structural conformations, motifs and domains, membrane proteins and stability; Ramachandran plot and backbone conformation; Free energy and thermodynamics, Thermodynamics of molecular interactions – molecular recognition, specificity, ultra-sensitivity of molecular interactions, Structure-function relationship

Unit 2: Molecular Cloning

Cloning methodology: Basic biology of cloning vectors: restriction enzymes; cutting and joining DNA molecules – Cohesive and blunt end ligation; Linkers; Adaptors, homopolymer tailing; cloning vectors - plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, yeast vectors; expression vectors and other advanced vectors in use; Plant based vectors; Ti and Ri as vectors; Methodologies - Insertion of Foreign DNA into Host Cells; Transformation; creating and screening of DNA library; Isolation of mRNA and total RNA; cDNA and genomic libraries; Jumping and hopping libraries; cDNA and genomic cloning; Southwestern and Far-western cloning; Expression cloning; Principles in maximizing gene Expression; Gene cloning and DNA analysis; Gene cloning in Medicine and forensic

Unit 3: Mutagenesis and Protein Engineering

Mutation – types, and repair mechanisms; Mutagenesis: Site specific mutagenesis; PCR in molecular diagnostics - Viral and bacterial detection; PCR based mutagenesis; Mutation detection techniques: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), Mismatch Chemical Cleavage (MCC), Allele-Specific Amplification, Protein Truncation Test; Protein engineering – introduction of new amino acids, creation of disulfide bonds, increasing or decreasing enzyme activity - Zinc-finger nucleases (ZFNs), Transcription activator-like effector nucleases (TALEN); Cre-Lox technology; CRISPR/Cas9-system

Unit 4: Animal Cell culture

Brief history of animal cell culture; Basic requirement for animal cell culture; cell culture media, serum and reagents; Culture of mammalian cells; tissue and organs; Primary and secondary cell culture; Continuous cell lines; Suspension culture; Common cell culture contaminants; Application of animal cell culture for toxicity study and production of vaccines and pharmaceutical proteins; Stem cells and their application

Unit 5: Comparative Genomics and Genome Mapping

Identification and classification of organisms using molecular markers - 16S rRNA typing/sequencing, single nucleotide polymorphism; Molecular markers as tools for mapping, restriction enzymes, restriction fragment length polymorphism, randomly amplified polymorphic DNA, simple sequence length polymorphism, amplified fragment length polymorphism; entire genome expression analysis - microarrays, expressed sequence tags, serial analysis of gene expression,

UNIT 1: Membrane and membrane Transport

Transport - recapitulation of the plasma membrane; mechanism of diffusion, facilitated diffusion, active transport with suitable examples; movement of water; Donnan equilibrium; ion movements and cell function: acidification of cell organelles and stomach; transepithelial transport; maintenance of cellular pH; cell excitation; bulk transport: receptor mediated endocytosis; protein sorting and targeting to organelles; molecular mechanism of the secretory pathway; secretion of neurotransmitters

UNIT 2: Cell motility and energetics

Cellular shape, motility and energetics- cytoskeletal elements in cell shape and motility: structure and dynamics; role in cell locomotion and mitosis; Intercellular communication: extracellular matrix; cell- cell and cell-matrix adhesion; gap junctions; cellular energetics: oxidation of glucose and fatty acids; shuttles across mitochondria; the proton motive force; F₀F₁ ATP synthase; mechanism and regulation of ATP synthesis.

UNIT 3: Cell Cycle

Life cycle of a cell - cell cycle and its regulation; checkpoints in the mammalian cell cycle; tumor suppressors and role of helicases; regulation of cell proliferation and differentiation by hormones, neuropeptides and growth factors; cell differentiation; apoptosis; turnover of cellular components: targeting of proteins to lysosomes for degradation; degradation of cytosolic proteins; cells in culture: requirements for cell culture; aseptic technique; primary culture; cell lines; organotypic cultures; cytotoxicity assays.

UNIT 4: Mutations; Oncogenes and Tumor suppressor genes

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Normal and cancer cells, Oncogenes - viral and cellular oncogenes (Proto-oncogenes, tumor suppressor genes and genome maintenance gene), Oncogenes as transcriptional activators; Tumor suppressor genes from humans; mutation and mis-regulation of cell growth and cell cycle; Function of pRB and p53 tumor suppressor proteins; Molecular approaches to cancer treatment

UNIT 5: Cell Growth and Apoptosis

Overview of the birth, lineage, and death of cells, fate of early embryo, Embryonic and Induced Pluripotent Stem Cells, Differentiation of stem cells and niche, Cell polarity and asymmetric division, Apoptosis – apoptotic pathways (intrinsic and extrinsic) and their evolutionary conservation, Caspase and apoptosis, role of mitochondria in apoptosis, Pro-apoptotic and antiapoptotic proteins.

UNIT 1: Overview of Immune System

Introduction- immunity- types- innate and acquired; Cell and organs involved in defense mechanisms of the body, Primary and Secondary lymphoid organs; Immunoreactive cells- structure and functions- macrophages, granulocytes, NK cells, T and B lymphocytes, lymphocyte subpopulation in humans, CD nomenclature.

UNIT 2: Immune responses generated by B and T lymphocytes

Immunoglobulins- assembly and secretion of immunoglobulins, Ig superfamily, antigenic determinants, organization of multigene, variable region gene arrangement, and expression of Immunoglobulin genes, class switching, diversity isotype, allotype, idiotype, differentiation and maturation, BCR; T-Cell organization, expression of genes, activation, differentiation, and maturation, TCR, Functional T-Cell Subsets; Cell-mediated immune responses, Antibody mediated effectors mechanisms.

UNIT 3: Regulation of Immune Response

Cytokines- Properties, receptors and cytokine antagonists, Cytokine secretion by TH 1 and TH 2 subsets, cytokine-related diseases, Therapeutic uses of cytokines and their receptors, Cytokines in Hematopoiesis; Complement system- function, components, activation and regulation of complement systems; Major Histocompatibility Complex (MHC)- Organization, types, distribution and regulation, MHC and immune-responsiveness- Processing of intracellular antigen for presentation by Class I MHC, Processing of antigen for Class-II MHC presentation follows a different pathway.

UNIT 4: Antigen – Antibody Interactions

Immuno-chemistry of Antigens- Immunogen, Immunogenicity and Antigenicity, haptens, hapten carrier system, Superantigen, Toxioids, Adjuvants, Immune modulators; Hybridomas, monoclonal, polyclonal; Antigen-Antibody interaction- Principles and applications, Thermodynamics and binding strength of Ag-Ab interaction- affinity, cross-reactivity, specificity; T cell B cell antigenic properties, epitope mapping, Precipitation, Agglutination; Advanced immunological techniques- RIA, ELISA, Western blotting, ELISPOT assay and Immunofluorescence.

UNIT 5: Clinical Immunology and Vaccinology

Immunity to Infection: Bacteria, viral, fungal and parasitic infections; Inflammation; Hypersensitivity–Type I-IV; Autoimmunity– type, mechanism and its treatment; Transplantation-Immunological basis of graft rejection, general and specific immunosuppressive therapy; Tumor immunology- Tumor antigens, Immune response to tumors and immune evasion by the tumor; Immunodeficiency- Primary and acquired immunodeficiency; Immunization- Active and Passive Immunization, Vaccinology- Rationale vaccine designs; Transfusion of immuno-competent cells; Stem cell therapy.

PAPER: ZOO-404C (P): PRACTICAL

4 CREDITS

1. Antigen-Antibody interaction: Single Radial Immuno-Diffusion/ Double Immuno-diffusion.
2. Comparative genomic DNA from fish, insect or blood.
3. PCR amplification using a universal primer
4. Protein profiling using SDS-PAGE electrophoresis.
5. HPTLC profiling of secondary metabolites from plants or animal source
6. Chromosome staining from different species.
7. Study of cell cycle.
8. Cell viability and toxicity assay.
9. Free radical scavenging assays.
10. In silico study of protein interaction with foreign substances.

Suggested Reading

- Cooper GM, Hausman RE (2013). *The Cell-A molecular Approach*. 6th Edition, Sinauer Associates Inc.
- Watson, J.D., Tania, A.B., Stephen, P.B., Alexander, G., Michael, L., Richard, L. (2017). *Molecular Biology of the Gene*. 7th Edition, Cold Spring Harbor Laboratory Press, New York.
- Brown, T.A. (2007). *Genome 3*. Garland Science Publishing
- Clerk, D.P. (2010). *Academic Cell - Molecular Biology*. Publisher - Elsevier Science
- Delves, P.J., Martin, S.J., Burton, D.R., Roit, I.M. (2011). *Essential Immunology*. 12th Edition, Wiley Blackwell Publishing.
- Glick, B.R., Pasternak, J.J., Patten, C.L. (2010). *Molecular Biotechnology: Principles and Application of r-DNA*. 4th edition, ASM Press, USA
- Primrose, S.B., Twyman, R.M. (2006). *Principles of Gene Manipulation*. 7th edition, Blackwell Publishing, USA.
- Goldsby, R.A., Kindt, T.J., Osborne, B.A., Kuby, J. (2003). *Immunology*. 5th edition, W. H. Freeman and Company, New York.

**Department of Zoology Bodoland University,
Kokrajhar Assam**
Syllabus for M.Sc. Sem IV Special Paper - Fish and Fisheries Science

Course structure:

Sl. No.	Paper Code	Title of Paper	Full Marks (Exam+Internal)	Credits
1.	ZOO-401F:FFI (Theory)	Anatomy and Physiology of Fish	80+20	4
2.	ZOO-402F FF-II (Theory)	Fish Diversity and Aquatic Resources	80+20	4
3.	ZOO-403F: FF-III (Theory)	Culture and Nutrition of Fish	80+20	4
4.	ZOO-404F: FF-IV (Practical)	Practical	80+20	5
5.	ZOO-405F: FF-V (Dissertation)	Dissertation	60+40	5

UNIT I: Feeding, Digestion and Gas exchange in Fish 12hours

Categories of food, Feeding habits and intensity. Structure of digestive system in different fishes; Associate digestive gland and their functions, Modifications of Digestive system in fish. Physiology of Digestion and absorption of food. Role of enzymes and hormones in the regulation of digestion. Structure of respiratory system in fin fishes: structure and function of gills; pseudobranch, Air breathing organs and their structures. Mechanism of gas exchange. Swim bladder and its modification (Dipnoi, teleostei), Gas secretion complex, weberian ossicle: structure, arrangement and functions. Bouyancy in fish.

UNIT II: Fish Circulatory and Excretory System 12hours

Hematology of fin fishes, Cardiovascular physiology of fin fishes, Gas transport, Acid balance. Comparative anatomy of Kidney in different fishes, rectal gland, chloride cell; Nitrogen excretion and metabolism, osmoregulation of fin fishes: osmotic regulation in freshwater and marine teleosts.

UNIT III: Reproductive and Endocrine System 12 hours

Structure and physiology of reproductive system of fin fishes, physiological adaptation for reproduction. Endocrine glands of fin fishes and their hormonal regulation, Neuroendocrine system of fin fishes. 2

UNIT IV: Bioluminescence and reception in fish 12 hours

Sources of colour: chromatophores; iridiocytes; control of chromatophores; effect of diet and water quality on colouration, structure of luminous organs or photophore; types of luminescence and control of luminescence; mechanism of light production from luminous organs; biological significance of luminescence; Families of light producing fishes. Important sensory organs in fish, electric organ, chemoreception etc. Lateral line system: structure and function.

UNIT V: Immunity, Stress and Diseases in Fish 12 hours

Phylogeny of fish immune system. Lymphoid tissues and cellular components of immune system. Basic principles of immune system in fishes, Endocrine control of immune system. Principles of stress resistance; stress tolerance, stress indicators in fish, Phagocytic systems; Antigen processing and MHC; Immunostimulant, immunomodulation. Parasitic and nutritional diseases: Infectious bacterial and viral diseases, water, soil, environmental parameters and their effects on fish health.

Suggested readings:

1. Pandey and Shukla (2010) Fish and fisheries, Rastogi publications.
2. Schreck, C.B.(2016) BIOLOGY OF STRESS IN FISH: Fish Physiology (Anthony P. Farrell and Colin J. Brauner) Academic Press(Elsevier) 125 London Wall.
3. Samantaray (2015) Physiology of Finfish & Shellfish, New India publishing agency.pp-
4. Moyle, P.B and Cech,J.J.(2011)Fishes: An introduction to Ichthyology(5th ed.)PHI learning private limited,New Dehli-110001.
5. Khanna, S.S and Singh, H.R. (2009) A text book of fish biology and fisheries.NPH,New Delhi 110006.
6. Bone, Q. and Moore, R.H.(2008) Biology of fishes (3rd ed). Taylore and Francis Group,USA & UK.
7. Secombes, C.J.,et al.(2009) Fish Defenses Volume 1: Immunology (Giacomo Zaccane ,A. GarcíaAyala,B.G. Kapoor) Published by Science Publishers, Enfield, NH, USA (printed in India).
8. Roberts, R.J et al.(2012)Fish Pathology (4thed) (Ronald J. Roberts).A John Wiley & Sons, Ltd., Publication.
9. von der Emde, R., Mogdans, J. and Kapoor, B.G. 2004. The Senses of Fish Adaptations for the Reception of Natural Stimuli. Narosa Publishing House, New Delhi, India.

Unit I. Diversity, Distribution and behavior of fish.

14 h

Classification and Identification of Fish. Methods employed in Phylogenetic Studies. Evolutionary Strategies. Diversity and Biogeographical distribution of major groups of fishes. Feeding, schooling, migration, courtship, mating and parental care in fish. Dams and their effect on fish migration. Larvivorous fishes. Impact of exotic fish species and GMOs on aquatic biodiversity. Biotechnology in fish conservation.

Unit II. Fisheries resources of India

12 h

Aquatic resource and livelihood. Riverine fisheries, Cold water fisheries, Estuarine fisheries (Chilka lake and backwater lagoons in Kerala), Marine fisheries of India. Ecology and fisheries of beels. Biology of commercially important fishes of India (sardine, mackerel, hilsa, mahseer). Development, Exploitation and management of Reservoirs. Impact of interlinking of rivers on fisheries.

Unit III. Morphometry, Fishing Techniques, Stock Assessment and Management.

12 h

Morphometric study of fish and its significance. Determination of age in fishes; Absolute and relative growth, growth curve, length-weight relationship, condition factor and their significance, Fecundity estimation. Fishing Techniques: Remote sensing, sonar, radar; crafts and gears. Fishways and screens. Marking, Tagging and Population enumeration. Fishing technology in India: Scope and present status. Types of fishing crafts and gears in marine and inland waters.

Unit IV. Fish preservation, by-product and extension services.

10 h

Fish and fisheries products, status and significance. Useful products from fish and its processing wastes. Causes of fish spoilage: biochemical changes during fish spoilage; Principle and practice of fish preservation; Fishery by-products. Fish conservation and Fishing laws. Extension services. and agencies involved in fisheries extension.

Unit V. Aquatic toxicology

12 h

Definition and principles. Bioavailability of chemicals. Bioaccumulation and biomagnifications. Factors influencing toxicity, Measurement and evaluation of the effects of toxicants; key target organs systems, Metabolism of toxic substances by aquatic organisms, toxicokinetics and biotransformation. Acute poisons and accumulative.. Toxicity Testing - Microcosm and Mesocosm Tests, Dose-Response Relationships, Toxicity Bioassay, genotoxicity assay, Biomarkers. Some case studies.

Suggested Literature:

1. Bone, Q. and Moore, R. 2008. Biology of Fishes. Talyor and Francis Group, CRC Press, U.K.
2. Helfman, G.S., Collette, B.B. and Facey, D.E. (Eds). 1994. The Diversity of Fishes. Blackwell Sceince, USA.
3. Love, M.S. and Cailliet, G.M. (eds). 1979. Readings in Ichthyology. Prentice-Hall of India.
4. Jayaram, K.C. 2009. Fundamentals of Fish Taxonomy. Narendra Publishing House,; 1st edition (1 January 2009)
5. Jhingran V.G. 1997. Fish and Fisheries of India. Hindustan Publications, Delhi, India. 6. ICAR (2018). Handbook of fish and fisheries of India. ICAR Publications, New Delhi India.
7. Nikinmaa, M. 2014. An Introduction to Aquatic Toxicology. Academic Press; 1st edition (8 August 2014)
8. Di Giulio, R.T. Hinton, D.E. (Eds.) 2008. The Toxicology of Fishes. CRC Press Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300. Boca Raton, FL 33487-2742.
9. Wetzel, R. 2001. Limnology Lake and River Ecosystems. Third Edition, Academic Press.

10. Vishwanath, W., Lakra, W.S. and Sarkar, U.K. Fishes of North East India, NBFGR Publication, Lucknow. 4. D. Kapoor, R. Dayal and A.G. Ponniah: Fish Biodiversity of India, NBFGR Publication, Lucknow. 11. Srivastava, C.B.L. A Text Book of Fishery Science and Indian Fisheries, Kitab Mahal , Allahabad

ZOO-403F: FF-III (Theory): Culture and Nutrition of Fish

4 Credits

Unit I. Introduction to Aquaculture

12 h

Definition and basis, history and present state. Site and species selection. Important aquaculture species. Water-quality criteria for Aquaculture: Role of temperature, pH, salinity, dissolved oxygen, ammonia, nitrite, nitrate, phosphate. Types of culture systems. Race ways, recirculating system, cage, pen. Fish-cum-livestock farming, paddy-cum-fish farming. Aquatic weed management, predatory and weed fish, aquatic insects and their controls. Recent developments in aquaculture research and technology.

Unit II. Breeding and Culture of Fish

14 h

Fish Seed: natural collection, Bundh breeding, Induced breeding, Cryopreservation of gametes. Construction and layout of fish ponds. Ecology of fish pond: Abiotic and biotic components; Food chain; productivity and its measurement. Concept of brood fish pond, hatchery, nursery and grow out ponds. Care and stocking rate, water quality management. Breeding and culture of carps. Ecology of swamps and their use for culture of air breathing fishes (Heteropneustus, Clarius, Channa and Anabas). Ornamental fish culture. Fish stock improvement through selective hybridization, selective breeding, gynogenesis, androgenesis, polyploidy. Production of monosex population, sex reversal, transgenic fish. Common diseases and its management in aquaculture. Fish quarantine.

Unit III. Nutrition in Aquaculture

10 h

Concept of feeding the fish, Principles of fish nutrition and terminologies. Nutritional requirements of commercially important fish. Bioavailability of nutrients. Food and feeding habits of cultivable fishes. Nutritional Physiology of food digestion in fish, Digestibility: significance and estimation. Broodstock and Larval nutrition. Types and components of artificial feed. Natural food and its importance, Bioenrichment. Biofloc and its significance. Food, fish growth and fish yield relationship.

Unit IV. Nutritional biochemistry and Bioenergetics

12 h

Classification, nutrient quality, requirement and evaluation of proteins, lipids and carbohydrates in fish nutrition. Protein to energy ratio, nitrogen balance index, protein sparing effect. Bioenergetics of fish, Energy Utilization and Requirements. Concept of Gross energy, digestible energy, Urinary, Branchial Energy and Metabolizable Energy. Factors Affecting Metabolic Waste Output.

Unit V. Feed Resources and Nutritional pathology

12 h

Types of feed resources. Nutritional value of feed ingredients. Non conventional feed resources. Artificial diet and its formulation. Novel feed and feeding mechanism. Feed additives (attractants, growth stimulants, probiotics, prebiotics and binders). Antinutritional factors and antimetabolites, microbial toxins, methods of elimination, nutrient deficiency and symptoms. Storage of aquafeeds and ingredients.

Suggested Literature:

1. Pillay, T.V.R. 2005. Aquaculture Principles and Practices. Second edition, Blackwell Publishing, USA.
2. Dunham, R.A. 2011. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI Publishing, USA.

3. ICAR (2018). Handbook of fish and fisheries of India. ICAR Publications, New Delhi India.
4. Jhingran V.G. 1997. Fish and Fisheries of India. Hindustan Publications, Delhi, India.
5. De Silva, S.S., Anderson, T.A. 1995. Fish Nutrition in Aquaculture. Chapman and Hall Aquaculture Series, London.
6. Lovell, R.T. 1998. Nutrition and Feeding of Fishes. Kluwer Academic Publishers.
7. Evans, D.H., Claiborne, J.B. 2006. The Physiology of Fishes. CRC Press
8. Halver, J.E. and Hardy, R. W. 2002. Fish Nutrition. Academic Press, London.

ZOO-404F: FF-IV (Practical)

5 Credits

1. Identification and study of some important Indian common fish faunal resources (cold, warm, brackish, marine, ornamental).
2. Study of different Types of scales, fins and otoliths.
3. Dissection, display and study of the following in fish: a) Weberian ossicles and their association with internal ear and air bladder b) visceral organs c) cranial nerves of selected fishes.
4. Preparation of fish skeleton; alizarine preparation.
5. Determination of age and growth, Hepatosomatic Index, Gastrosomatic Index and Gonadosomatic Index.
6. Length-weight relationship and condition factor determination.
7. Comparative study of feeding habits of different fish by gut content analysis.
8. Comparative study of digestive enzymes of herbivore, carnivore and omnivore fishes.
9. Accessory respiratory organ of the some air breathing fish (Clarias, Heteropneustes, Anabas, Channa).
10. Demonstration of surgical procedures (hypophysectomy/gonadectomy) of fish.
11. Preparation of formulated diets for fish larvae and adult.
12. Physico-chemical parameters (temperature, pH, conductivity, turbidity, transparency, dissolved oxygen, Free CO₂, alkalinity, hardness, nitrite-nitrate, phosphate) of freshwater/pond water.
13. Study of phytoplankton, zooplankton and benthic macroinvertebrates from natural resources.
14. Collection and identification of aquatic weeds and aquatic insects.
15. Identification and study of various types of fishing gears and nets.
16. Simulated experiments on population enumeration.
17. Estimation of species diversity, richness and evenness.
18. Demonstration of Induced breeding of Indian major carps/catfishes.
19. Visit to a local fish market and survey of fish and shellfish species.
20. Visit to freshwater fish farm/breeding ponds and hatcheries/marine fish farm/reservoir/biofloc facility.

ZOO-405F: FF –V (Dissertation)

5 Credits

The students will take up a project/survey/review/experimental work based on topics of relevance to the subject specialization and in consultation with their respective supervisor/guide to be completed within the period of the course. The work shall be based on proper methodology and protocols, and submitted in appropriate format to the department within stipulated time. The guidelines for the dissertation work may be notified by the department from time to time. The final submission of hard bound thesis, presentation and viva voce shall carry 60% marks, and 40% marks are to be evaluated internally by the supervisor which may consist of (but not necessarily restricted to) the following: rationality, scientific validity, methodology punctuality, timely progress, internal test/examinations etc.

FOURTH SEMESTER
SPECIALISATION: WILDLIFE ECOLOGY
PAPER: ZOO-401: WE-I (Theory): Basics about Wildlife Ecology
4 Credits (Marks: 20 + 80)

Unit I

Introduction to wildlife: definition, concept, importance and values of wildlife; Biogeographical concepts: ecology of dispersal and faunal exchange, biogeographical process, endemism, biogeographical realms, provinces and ecoregions. The biogeographic affinities of the fauna and flora of the Indian subcontinent; island biogeography, metapopulation concept.

Unit II

Taxonomy and Systematics of Animals: classification and nomenclature issues of vertebrates, Taxonomy as a basic tool in wildlife research; natural selection and speciation: biological, phylogenetic, evolutionary and ecological species concepts; Classification up to order of major taxa: insects, fishes, amphibia, reptiles, aves and mammals.

Unit III

Concept of biodiversity: Species diversity, Genetic diversity and Ecosystem biodiversity; biodiversity hotspots, measurement of biodiversity: species richness, evenness; Factors governing species diversity; Threats to biodiversity, causes and consequences of biodiversity loss and decline; Urban Wildlife diversity, case studies.

Unit IV

Habitat Ecology: concept of habitats, major habitats of animals; habitat fragmentations and gap formation; Landscape Ecology: Fundamentals of Landscape Ecology, Ecological and Spatial Scales, Drivers of Landscape Change. Wetland ecology: Definition of wetlands, classification and values of wetlands; streams and rivers and important wetlands of Assam; Urban Ecology: Ecological aspects of urbanization.

Unit V

Animals Diversity and Distribution: Diversity and distribution of butterflies in northeast India, seasonal and altitudinal migration; Ichthyogeography and diversity of freshwater fishes of India with special reference to Assam; Zoogeography of amphibians and reptiles, Factors affecting distribution and abundance of amphibian and reptilian fauna of the Indian sub-continent. Biogeographic patterns in Indian avifauna and their affinities; Diversity and distribution of Indian mammals.

PAPER: ZOO-402: WE-II (Theory): Conservation Biology

4 Credits (Marks: 20 + 80)

Unit I

Population Ecology: monitoring of wildlife population other demographic parameters, different population estimation techniques; Population dynamics: population regulation, natality, fecundity, density, mortality; Predator-Prey Dynamics; Occupancy Modelling. Animal dispersion: immigration, emigration, migration in different taxa with examples in details.

Unit II

Community Ecology: Community structure, organization and its stability (guilds, resource partitioning, niche, competitive exclusion). Social organization in invertebrates and vertebrates; socio-biology of insects, birds and mammals with examples in details. Group living: costs, benefits and optimal group size.

Unit III

Behavioural Ecology: Concept of Ethology; Pattern of behavior: Innate behavior, learned behavior; Adaptation; Evolution of unsocial behaviour; Altruism; Communication in animals and their methods; Sexual selection: parental care and mating systems, polygyny, polyandry, promiscuity; Foraging ecology of animals: optimal foraging theory; home range, territory.

Unit IV

Conservation Ecology: Viable population, Population and Habitat Viability Assessment (PHVA), carrying capacity; Conservation Assessment and Management Plan (CAMP); Biological Invasion: exotic, invasive and introduced species of plants and animals; Bioindicators: bioindicator species of plants and animals; Animal corridor; Ecotone and Edge effect; Wildlife Health: emerging wildlife and zoonotic diseases, Wildlife-livestock interface and conservation, Determinants of disease and disease transmission. Climate change: Effects of climate change on wildlife.

Unit V

Wildlife Biology Case Studies: Introduction to threatened species of butterflies, fishes, herpetofauna, birds and mammals of Northeast India. Biology of butterflies and moths, host plants and nectar plants, mud puddling; Ecology and adaptation of fishes in different ecosystems; Biology of major Indian amphibians and reptiles; Biology of endangered bird species of India; Biology of endangered mammal species of India.

PAPER: ZOO-403: WE-III (Theory): Applied Wildlife Science

4 Credits (Marks: 20 + 80)

Unit I

Conservation of Wildlife and management: Wildlife (Protection) Act 1972; Conservation Practices in NE Region of India: In-situ and Ex-situ conservation; Introduction, reintroduction and translocation of wild animals; Concept of Keystone, Flagship and Umbrella species; IUCN Criteria of Threatened Wildlife; Conservation Breeding Programme with few successful case studies in India; Wildlife Management Plan, controlled burning.

Unit II

Protected area network: reserve forest, wildlife sanctuary, national park, Biosphere Reserve, Conservation and Community Reserves, Community Conserved Areas (CCA) wildlife outside PAs, Tiger Reserve, Elephant Reserve, Important bird and Biodiversity Areas (IBA) in India, eco-sensitive zones. Major International and National Organizations in Wildlife Conservation: IUCN, UNDP, FAO, WWF; BNHS, SACON, National Biodiversity Authority (NBA), Convention on Biological Diversity (CBD), Central Zoo Authority (CZA); Convention on wetlands of international importance: Ramsar Convention.

Unit III

Human dimensions in Wildlife Management: Human-wildlife conflict, case studies in India with special reference to northeast India; Wildlife crime: Wildlife trade, hunting, poaching; CITES, TRAFFIC; Sustainable Biodiversity Conservation: Ecosystem people; Sacred groves, home garden; Citizen science: e-bird, Birdcount India; Ecotourism: definition and scope, wildlife tourism; Environment Impact Assessment (EIA): Basic concepts & objectives of EIA, Relationship between EIA and wildlife conservation;

Unit IV

Modern technology in wildlife research: Overview of research methods, techniques and application; Introduction to Remote Sensing: Definitions, concepts and types of remote sensing and advantages of remote sensing; Principles of GIS and GPS: Basic concepts of GIS, Components of GIS, Data structure and formats Spatial data models; Fundamentals of GPS, Components of global positioning system; Mark-release-recapture technique, Camera trapping; Bird Ringing, Use of Transmitters, PTT; Radio telemetry, Micro Chips, Radio collar; Satellite tracking.

Unit V

Conservation Genetics: Application of genetics for wildlife conservation; PCR, DNA Sequencing, DNA Finger Printing, Loss of genetic diversity, Genetical Depression, Demographic bottlenecks. Wildlife forensics: Overview, various forensic protocols for species identification, Molecular markers used in wildlife forensics; Wildlife forensics based on DNA analysis and morphometry; Scat/dung analysis techniques, hair and feather analysis techniques.

PAPER: ZOO-404: WE-IV (Practical): Applied Wildlife Ecology

4 Credits (Marks: 20 + 80)

- 1) Research questions and research hypotheses designing. Research methodology exercise.
- 2) Concept of data collection, datasheet preparation, work plan designing.
- 3) Sampling approaches: Complete Random Design, Stratified Random Design, and Sampling methods for estimation of terrestrial vegetation: the nearest individual method, point-centred quarter method, line intercept method, quadrat sampling method, crown-canopy estimation method, estimation of canopy cover using ocular method. Species-area curve.
- 4) Estimation of quantitative and qualitative characteristics of plant community: frequency, density, abundance, basal area and phenology. Estimation of Important Value Index (IVI)
- 5) Wildlife population estimation by: Line transect method, point count method, belt transect method, marked-recaptured technique; encounter rate; Indirect Methods: Pellet Group counting methods, scat/dung analysis, sign survey analysis.
- 6) Analysis of species diversity: Shannon-Wiener Index, Simpson's Index; Similarity Index.
- 7) Methods of behavioural observation: focal animal, all-occurrence and one-zero sampling, Scan animal sampling; collection and analysis of behavioural data on some common availability species; time-activity budgets and preparation of ethograms of studied animal species.
- 8) Identification test of wildlife specimen.
- 9) Collection of location data by hand-held GPS; False colour composition (FCC) interpretation; manual landscape mapping.
- 10) Questionnaire and Schedule preparation. Analysis of pressure and resource dependency of local communities upon PAs; and Community survey methods including participatory learning methods.
- 11) Excursions to nearby forests, grasslands and wetlands under various management regimes; visit to wildlife sanctuary and national park for proper orientation with wildlife diversity; Field report preparation.
- 12) Statistical analyses of data collected during field exercise.
- 13) Seminar presentation and viva-voce.

References

David Ford. E. 2000. Scientific method for ecological research. Cambridge University Press

Javed, Salim and Kaul, Rahul 2002. *Field Methods for Bird Surveys*. Bombay Natural History Society; Department of Wildlife Sciences, Aligarh Muslim University, Aligarh and World Pheasant Association, South Asia Regional Office (SARO), New Delhi, India.

Lillesand. M. Kiefer, R.W. and Chapman, J.W. 2008. *Remote Sensing and Image Interpretation*. John Wiley and sons.

- Marten, P. and Bateson, P. 1986. *Measuring Behaviour-An introductory guide*, Cambridge University Press. New York, Collier Macmillan Publishers.
- Michael, P. 1984. *Ecological Methods for field and laboratory investigation*. Tata McGraw-Hill, New Delhi.
- Misra, R. 1968. *Ecology Work Book*, Oxford and IBH Publishing Co. Calcutta.
- Moore, P.D. and Chapman, S.B. 1986. *Methods in Plant Ecology*. Blackwell Scientific Publications.
- Morrison, M.L. et al. 2001. *Wildlife study design*. Springer-Verlag, New York, NY
- Southwood, T.R.E. and Henderson, P.A. 2000 (third edition) *Ecological Methods*. Blackwell Science.