

P.G. 3rd SEMESTER SYLLABUS
DEPARTMENT OF ZOOLOGY
COTTON UNIVERSITY

PAPER: ZOO901C

MOLECULAR BIOLOGY AND ANIMAL BIOTECHNOLOGY
(Credits: 3+0+1=4)

A. MOLECULAR BIOLOGY

Unit1: Molecular biology (22L)

1. Structure of protein, Domains and motifs, 2. Transcription factor, 3. Protein folding, Ramchandran plot. 4. Molecular chaperons; 5. Genome organization in prokaryotes, eukaryotes & genome complexity. 6. Recombination, 7. Mobile genetic elements; 8. DNA damage & repair-types of DNA damages and repair systems. 9. Model organisms for molecular studies; 10. Somatic cell hybridization and chromosome mapping, Cell fusion and applications, 11. Construction of cDNA & genomic DNA libraries.

B. ANIMAL BIOTECHNOLOGY

Unit2: General biotechnology (26L)

2.1 Use of animals as bioreactors; 2. Animal breeding & care; 3. Uses of animals in experiment: Selection rationale & cruelty. 4L

2.2: Cell culture 8L

1. Cell culture – a) Equipments and materials for cell culture technology, b) principle of sterile techniques and cell propagation, c) primary and established cell line cultures. 2. Mammalian cell lines & their characteristics. 3. Basic techniques of mammalian cell culture, disaggregating of tissue, maintenance of cell culture, cell separation, cell synchronization, cell cloning, micromanipulation, cell transformation.

Unit 3: Recombinant organisms and transgenic animals 5L

1. Transgenic animals; creation of transgenic mice, retroviral vector method, Microinjection, embryonic stem cell method – short gun, electroporation, lipofection, microinjection. 3. Production of other transgenic animals – cattle, sheep, pigs and fish.

Unit 4: Application of Biotechnology 9L

1. Application of RFLP in forensic science, 2. hybridoma technology and Production monoclonal antibodies. 3. Environmental Biotechnology - biosensors in ecotoxicological screening; 4. Biofuels & biogas production 5. Biohazard & biosafety level-I, II, III, IV 6. Intellectual property right (IPR)

PRACTICAL: Molecular Biology and Applied biotechnology, Molecular techniques. Credit: 1

1. Study of colchicised metaphase chromosome in bone marrow of rodent species (mouse) by airflame dry method.
2. Study of sex chromatin in human female from hair bud cells.
3. Preparation of human karyotype.
4. Demonstration of culturing of E Coli on solid on liquid medium.
5. Demonstration of bacterial transformation using suitable plasmid (with and without insert).

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6. Identification and study of male and female drosophila, study of mutant variety of drosophila – eye and body colour, body pattern, wings development from the permanent slides.
7. Demonstration of SDS-PAGE for protein and visualization.
8. Demonstration of Agarose gel electrophoresis for DNA.
9. Estimation of cholesterol and LDH.
10. Demonstration of animal culture lab.

PAPER: ZOO902C

HISTOLOGY & HISTOCHEMISTRY, TOXICOLOGY
(Credits: 3+0+1=4)

Unit 1: Histology (19L)

1.1. Techniques of histology: 6L

1. Mechanism of Fixation and Fixatives-Types, Chemistry & Choice of Fixatives 2. Tissue Staining- Principle and Mechanism of histological staining, different types of dyes &, dye binding reactive groups, Histological stains; mordants & mordanting & histological lake, double staining technique 3. Tissue processing through microtomy technique- narcotization & excise the tissue sample, fixation processing, Dehydration, Clearing and Embedding, block making & trimming, sectioning & stretching.

1.2: Histopathology: 10L

1. Histological structure & functions of liver, kidney, & brain; 2.. Histological structure & functions of immunological organs thymus, spleen; 3. Cellular behaviour in pathological state; 4. Cell injury- definition, pathogenesis of reversible & irreversible cell injury, concept of free radicals, oxidative state & oxidative stress; 5. Thrombosis- definition, types & mechanism of thrombosis, 6. Healing- definition, mechanism & factors controlling cellular healing.

Unit 2: Histochemistry and toxicology: 8L

1. Principle and methods of histochemical reaction and localization of the following: Carbohydrate moieties: by PAS (Periodic Acid Schiff) method; 2. Protein by bromophenol blue method; 3. Lipid moieties by Sudan black B method, 4. Nucleic acid: by methyl green pyronin method. 5. Enzymes: alkaline phosphatase by metal precipitation method, cytochemical detection of calcium; 6. Basic concept and scope of toxicology, 7. Toxicity principle and methods, 8. Different types of toxicity test (chronic, subchronic, acute, subacute); 9. Dose response relationship, calculation of LD₅₀, LC₅₀, ED₅₀, TI Index.; 10. Food toxicant and their control method; 11. Metal toxicity on animal.

Unit 3: Bioinstrumentation -1

1. Principle, different types of centrifugation (differential, density gradient and ultra centrifugation) and biological applications. 2. IR and NMR spectroscopy. Principle and application in biology. GM tube and liquid scintillation counter, 3. Microscopy- a) principle of microscopy and application- Bright-field microscope, Dark-field microscope, b) Phase-contrast microscope, 4. Principle & application of a) Fluorescence microscope, Confocal microscope, b) electron microscopy (SEM & TEM), 5. Spectrophotometric techniques – principles and biological applications of UV, Atomic absorption and mass

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spectroscopy, 6. Chromatographic techniques – principle and types, applications of Gel filtration, ion-exchange, column, TLC, GC, HPLC; affinity of chromatography 5. Principle and application of autoradiography techniques

Unit 4: Bioinstrumentation -1I (8L)

1. Electrophoresis techniques – principles and applications of Agarose- and polyacrylamide gel, Two-dimensional (2D), Isoelectrofocussing electrophoresis. 2. PCR techniques- RT-PCR & QPCR, principle & application. 3. Flowcytometry-principle & bio- application, 4. Microarray techniques, 5. ELISA, 6. Fluorescence in situ hybridization (FISH) technique.

PRACTICAL: Credit: 1

1. Preparation of commonly used fixative, stain, vital and supra vital stain.
2. Histological preparation of tissue for microtomy technique. Paraffin (Necrotization, fixation, dehydroxation, Clearing, paraffin embedding of tissues from any vertebrate specimen, sectioning of paraffin block, stretching and spreading sections on slides).
3. Histological staining of paraffin tissue section using H & E method.
4. Supra vital staining of blood cells/spleen.
5. Histochemical detection of glycogen, acidic glycoprotein by PAS and Alcian blue (pH 2.5) techniques.
6. Histochemical detection of alkaline phosphatase in situ.
7. Histochemical/cytochemical detection of nucleic acid (DNA and RNA) by methyl given pyromin method
8. Detection of DNA by Feulgen method.
9. Cytochemical detection -SH group for blood sample
10. Study of histopathological and cytopathological changes. Cells or tissue samples from permanent slides or photographs (cytomorphology blood, carcinoma cell, tissue necrosis and degenerative changes, fatty infiltration, cytolysis).
12. Microscopic measurement of cell by ocular and stage micrometer.

Books recommended:

1. Bancroft, J.D. & Stevens, A. Theory and Practice of Histological techniques, Churchill-Livingstone, 2002
2. Casselman, W.G.B. : Histochemical techniques, John Wiley, 1959
3. Pearse, A.G.E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill-Livingstones, 1980-1993
4. Nelson et al: . Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
5. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
6. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004
7. Principles of ecotoxicology- 3rd edition 2006, C H Walker, S P Hopkin, R N Sibly and D B Peakall (Eds.), Taylor and Francis, NewYork, NY.
8. Introduction to Environmental toxicology -3rd edition 2003, W.G.Landis and M.H.Yu. Lewis publishers, Florida.
9. Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patrica Levi, McGraw –Hill International edition. Singapore.

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PAPER: ZOO903C

ENDOCRINOLOGY AND BEHAVIORAL SCIENCE
(Credits: 3+0+1=4)

A. ENDOCRINOLOGY

Unit1: Non-mammalian and mammalian endocrinology

1. Non-mammalian 2L

1. Endocrine control of molting & reproduction in insect, 2. Structure of Pineal gland & its functions.

1.2 : Mammalian endocrinology 12L

1. Introduction to endocrine system & classes of hormones-peptide, protein, steroid & prostaglandins, 2. Endocrine cells of pancreas, pancreatic hormones & its role in glucose homeostasis 3. Thyroid Gland- Biosynthesis of thyroid hormones, Control of secretion & their Physiological roles. 4. Adrenal gland- a) its secretion, physiological action of adrenal hormones b) Adrenal Medullary hormones-Catecholamine biosynthesis, release and its physiological roles, 5. Synthesis of steroid hormones & synthesis of corticosteroid hormones, 6. Role of parathormones in Calcium & phosphate homeostasis, Hormones as second messenger.

Unit 2: Reproductive endocrinology 10L

1. Testis- Organization, Physiological roles of androgens & inhibin, Ovary- Organization, Physiological roles of Estrogen, Progesterone, Relaxin&Inhibin. 2. Human reproductive pheromones, role of pheromones in puberty, Physiological changes & hormonal regulation of onset puberty 3. Placental hormones,

Unit 3: Endocrine disorders 6L

1. Overview of endocrine disorders-a). Pituitary gland- Acromegaly & Diabetes insipidus b). Thyroid gland- Goiter & Myxoedema c). Parathyroid gland- Osteoporosis d). Islets of Langerhans- Diabetes mellitus e). Adrenal gland- Cushing's syndrome f). Ovary & female infertility- Polycystic ovarian disease g). Obesity

B. ANIMAL BEHAVIOUR

Unit4: Behavioural biology (18L)

4.1: Biological Rhythms & control: 6L

1. Definition & types of rhythms, Zeitgebers, circadian rhythms, Basic types of exogenous rhythms in the human and their significance, Photoperiodism, annual and lunar periodicity. 2. Role of melatonin & neurotransmitters in circadian control, Role of SCN in the human, photic and non photic pathways, pacemaker function of the SCN.

4.2: Mimicry & coloration: 3L

1. Definition of mimicry & coloration, Types of mimicry, Batesian and Mullerian mimicry and significance.

4.3: Interspecific relationship: 2L

1. Definition of Interspecific relationship, Aggregations and social organization.

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4.4: Animal behavior & pattern: 7L

1. Animal behavior-innate or inherent behavior, learned behavior, vision and behavior, sound and behavior, Social behaviour: mating, family, and group behavior, advantages of social behavior, Habitat selection and foraging behavior 2. Genetic, hormonal and evolutionary aspects of behavior. 3. Sexual conflict & Sexual selection: a) intra sexual selection (male rivalry), b) inter-sexual selection (female choice), c) infanticide, sperm competition, d) mate guarding, sexual selection in human, e) consequences of mate choice for female fitness, f) monogamous versus polygamous sexual conflict. 4. Parental care.

PRACTICAL: Non-mammalian and mammalian endocrinology and behavioral science Credit:1

1. Dissection of pituitary gland from suitable marketed fish
2. Demonstration of thyroid, adrenal, pancreas & gonads of any suitable vertebrate specimen through dissection
3. Dissections of neuroendocrine complex in insect (cockroach)
4. Parabiosis (parabiotic behavior) in cockroach
5. Study of histological preparation of pituitary & thyroid gland
6. Study of pituitary, thyroid, parathyroid, pancreas, adrenal, testis & ovary of mammal through permanent slides
7. Castration & ovariectomy in rat
8. Identification of gonadotropin in human urine sample
9. Effect of insulin/ adrenaline on blood glucose level in rats
10. Study of median threshold concentration of sucrose/glucose solution in eliciting feeding response in ants
11. Methylene blue visualization of sensory neurons in *Drosophila*
12. Recording & analysis of insect (cricket) & birds calls
13. Study of social insect colonies
14. Study of laboratory behavior in mice by using zigzag or T-shaped maze
15. To study the geotaxis behavior of worm
16. To study oriental responses of 1st instar larva of photo stimuli

Books recommended:

1. Comparative Endocrinology of Invertebrates by Highman and Hill.
2. Comparative Vertebrate Endocrinology by P.J. Bentley, Cambridge Univ. Press.
3. General and Comparative Endocrinology by E.J.W. Barrington, Oxford Clarendon Press
4. Endocrinology Vol.1-3 by DeGroot L.J. et al.
5. Text Book of Endocrine Physiology by C.R. Martin, Oxford Univ. Press, New York.
6. Text Book of Endocrinology by Turner and Bangnara (W.B. Sanders).
7. Vertebrate Endocrinology by Mc. Hadley.
8. Text Book of Comparative Endocrinology by Gorbman A, and Bern H.A., John Harley and Sous, New York.
9. Alcock : Animal Behaviour- An Evolutionary Approach. (7th ed.) Sinaur Associates, Inc. 2001.
10. Drickamer & Vessey: Animal Behaviour –Concepts, Processes and Methods (2nd ed.), Wadsworth, 1986.
11. Gadagkar: Survival Strategies-Cooperation and Conflict in Animal Societies. Universities Press, 1998.

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(Special Paper)

PAPER: ZOO904S

CELL & MOLECULAR BIOLOGY - I
(Credits: 3+0+2=5)

A. CELL STRUCTURE & DYNAMICITY

Unit 1: Cell structure & Cell cycle (23L)

1.1: Cell cytoskeleton: 5L

1. Prime cytoskeletal proteins & functional roles 2. Assembly & disassembly of microtubules, dynamic stability of microtubule proteins, molecular motor, cargo protein 3. Actin structure, polymerization & actin binding protein 4. Intermediate protein (laminin) & role in evolution of cellular regulation.

1.2: Chromosome structure: 7L

1. Circular & linear chromosomes, Ultrastructure of chromosome based on different models (multiple strand, single strand, unine, molecular model, 2. Variations & abnormalities in chromosome structure & number (breakage, fusion-bridge cycle, deletion, duplication, translocation, aneuploidy, polyploidy) 3. Satellite chromosome & satellite DNA 4. Role of centromere & telomere in chromosome & Chromosome condensation 5. Nucleosome & its phasing 6. Sex determination & dosage compensation & Mitochondrial inheritance

1.3: Cell cycle, cancer & apoptosis: 5L

1. Cell cycle- molecular basis of mitosis & meiosis, mitotic inhibitors 2. Cyclins & CDKs in cell cycle phases & Molecular mechanism of M-CDK activation 3. Genetic regulation of cell cycle, deregulation led to cancer 4. Molecular basis of cellular checkpoints & their roles in cell 5. Synaptonemal complex & recombination molecule 6. Ageing: Cellular & molecular mechanism of ageing, genetic control, Oxidant as a major contributor to cancer & ageing.

1.4 Cancer & apoptosis- 6L

1. Epidemiology, causes, properties & types of cancer 2. Proto-oncogene & viral oncogene, mechanism of oncogene activation, Tumor marker & tumor suppressor genes 3. Molecular approaches in cancer therapy 4. Apoptosis & pathways (Caspases 5. Bcl2, P53, Bax & BAK gene activation pathways of apoptosis, Mitochondrial pathways of apoptosis).

Unit 2: Cell signaling & communication (13L)

2.1: Cell signaling & receptors: 4L

1. Cell signaling molecules & forms of intracellular receptors, Surface receptors & cytokine receptors 2. Mechanism of signaling from plasmamembrane to nucleus 3. Signal amplification & signal transduction pathways (JAK-STAT, MAP kinase, RTK & RAS, TGF signaling, Wnt & Hedgehog pathways).

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2.2: Cell communication 5L

1. Cell-cell adhesion by cadherin & selectin 2. Cell junction & organization (Tight junction, Gap junction, anchoring, 3. Cell- matrix interaction-integrin, collagen & fibronectin 4. Focal adhesion & desmosome, Extracellular matrix, 5. Compartmentalization of cell organelle & peroxisomes

2.3: Protein sorting & protein transport 4L

1. Insertion of protein in ER, intracellular & molecular mechanism of protein transport (Golgi trafficking, Clathrin Cop I & Cop II mediated transport), 2. Receptor mediated endocytosis & Regulatory protein in transport (SNARF & Rab protein), Lysosomal assembly & function.

B. MOLECULAR CYTOLOGY

Unit 3: DNA damage & repair mechanism 5L

1. Free radicals & damage to DNA & nucleoprotein, DNA damage by photosensitization 2. High fidelity of DNA sequence & Concept of eukaryotic DNA repair system (Direct repair, mismatch repair, basic excision repair, recombinant repair) 3. Role of DNA polymerases in error correction of replication.

Unit 4: Human Molecular Genetics 7L

1. Basic attributes and polymorphic structures in human protein coding genes. 2. DNA polymorphism (Y-chromosome polymorphism and Single nucleotide polymorphism (SNP), Basic concept in Molecular phylogenetics) 3. Molecular biology in forensic science: (Protein comparisons, DNA comparisons, RFLPs, genetic finger-printing, VNTRs) 4. Human genome projects & age of genomics.

PRACTICAL: Credit: 2

(Cell structure, Dynamicity, Molecular Cytology)

1. Total leucocyte, erythrocyte and differential count of leucocyte.
2. Preparation & study of effect of colchicine treatment on the behaviour of mitotic chromosome in onion root tip/ mouse bone marrow.
3. Preparation of sex chromatin (Barr body) from human buccal epithelium.
4. Preparation of chromosome bending pattern (G-C) from the mitotic chromosome preparation from the mammalian blood/bone marrow.
5. Supra-vital staining of living cell from blood/lining protozoan/spleen
6. Detection of localization (changes in epithelial cell, liver/kidney) of some cell organelle (mitochondria, Golgi - in situ) from the chick epithelial cell/liver/kidney cells by using specific stain.
7. Histochemical localization of lipid peroxidase granules.
8. Identification and localization of nucleolar organizer region (NOR) on polytene/bone marrow chromosome.
9. Preparation of cell suspension and assays (count of) viable cells by trypan blue exclusion.
10. Cell viability by MTT assays/Assaying of phagocytosis in mouse macrophage.
11. Assaying of apoptosis in mouse thymus cell by acridine orange and propidium iodine staining.
12. Cytochemical/ histochemical detection of lipid granules by Sudan Black method from blood/animal tissue.

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13. Study of behavioural response of erythrocyte cell to different concentrations of physiological saline.
14. Determination of oxidative stress enzyme SOD/LPO/Catalase.
15. Identification of different types of cancer cells from permanent slides
16. Study of mutant variety of *Drosophila*
17. Practical record book & viva voce.

Books recommended:

1. G.M. Cooper and R.E. Hausman: The Cell, A Molecular Approach. 5th Ed. ASM Press (2009)
2. Bostock & Sumner: Eukaryotic Chromosome (North-Holland, 1987)
3. Karp: Cell and Molecular Biology (John Wiley & Sons, 2002)
4. Lewin, Genes VIII (Wiley, 2004)
5. Lodish et al: Molecular Cell Biology (Freeman, 2000)
6. Pollard & Earnshaw: Cell Biology (Saunders, 2002).
7. Alberts et al: Molecular Biology of the Cell (4th Ed.), Garland, 2002
8. A. Paul: Cell and Molecular Biology, Books and Allied (P) 2nd Edn. (2009)
9. Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
10. DeRobertis & DeRobertis: Cell & Molecular Biology, Lea & Febriger, 1987
11. Friefelder: Molecular Biology
12. Darnell, Lodish and Baltimore: Molecular cell biology (Scientific American Books)
13. H. D. Kumar: Molecular biology
14. W. H. Elliot and D. C. Elliot: Biochemistry and molecular biology by (OU Press)
15. G. Plopper, D. Sharp, E. Sikorski: Lewin's Cells, 3rd Edn. Jones and Bartlett Learning.

PAPER: ZOO905S

ECOLOGY AND WILDLIFE BIOLOGY – I

(Credits: 3+0+2=5)

Unit 1— Environmental variables and limits, Community (14L)

1.1— Environmental variables and limits 7L

1. Organism and its environment: Limits of Tolerance, 2. Adjustment to tolerant limit, 3. Interaction between environmental variables, 4. Macro and micro environments.

1.2—Community (7L)

1. Community and ecosystem; community level organisation, 2. Analysis of food web design, nutrient flow within community, 3. Niche relationship, parallel and niche overlaps and competition, niche separation, 4. Population structure, population cycles in invertebrates.

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Unit 2- Species diversity and coevolution, Stability (13L)

2.1- Species Diversity (7L)

1. Diversity as a descriptor of ecological community, 2. Measures of the diversity, factor promoting species diversity, 3. Co-evolution, plant-insect interaction, larger herbivores population, 4. Theories of diversities and factors promoting species diversity

2.2- Stability (6L)

1. Definition, stability of single species, two three species system, 2. Diversity and stability, May's paradox, 3. Stability of food web design, 4. Energetic of stable system

Unit 3: Ecosystem and its Productivity, Energy and Mineral cycle (14L)

3.1- Ecosystem and Its Productivity (7L)

1. Types of forests, wetland and grassland, 2. Ecosystem productivity, 3. Methods of Assessment of Ecosystem Productivity, 4. Ecosystem Goods and Services, Green India Mission

3.2 Energy and Mineral cycles (7L)

1. Energy flow model, application of law of thermodynamics, 2. Hydrological, mineral cycle, 3. Artificial inputs in ecosystem and its impact, 4. Soil: structure, characteristics and agricultural practices

Unit 4— Ecosystem service and livelihood issues (7L)

1. NTFP (Non timber forest product), Rural employment and ecosystem services, MGNREGA, 2. Forest right act, biodiversity act 2002, IPR, Ramsar conventions, 3. Wetland and forest ecosystem service, 4. Climate change- expected impact on ecosystem service, pollinators

PRACTICAL:

1. Ecological sampling and census techniques
2. Field equipments on population study and analysis, camera trapping
3. Estimation of density, frequency and abundance of animals/ plants in a community using transect/ quadrat methods.
4. Study of diversity index/ dominance index
5. GIS, GPS and RS technology.
6. Practical Record book and Viva voce

Books Recommended:

1. Anathakrishnan : Bioresources ecology, Taylor and Francis, 1982
2. Bouhey : Ecology of populations, (2nd edition) Macmillan, 1973.
3. Dowdoswell : An introduction to animal ecology, Methien, 1967.
4. Kormondy : Concepts of ecology, Prentice-Hill, 1984
5. May : Stability and Complexity in Model ecosystems (Vol.6th). Princeton university press, 1974

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6. Odum : Fundamental of Ecology (5th edition), Thomas Brooks/ Cole, 2005.
7. Pawlosuske :Physico-chemical methods for water and wastewater treatment (vol 19) Elsevier, 1982.
8. Wetzel : Limnology: Lack and River Ecosystem (3rd edition) Academic press 2001.
9. Arora : Fundamentals of environmental biology
10. Anathakrishnan :Bioresources ecology, Kalyani publishers 1985.

PAPER: ZOO906S

ENTOMOLOGY – I

(Credits: 3+0+2=5)

(INSECT STRUCTURE AND FUNCTION, ECOLOGY)

Unit 1 : 5L

1. Modern scheme of classification of insects, distinguishing characters, general biology, habit and habitats of insect orders.

Unit 2 : Insect morphology 16L

1. Head – origin, structure and modification – types of mouthparts, antennae, tentorium and neck sclerites; 2. Thorax – areas and sutures of tergum, sternum and pleura, wings: structure and modifications; venation, wing coupling apparatus and mechanism of flight, legs: structure and modification – mechanism of walking; 3. Abdomen – segmentation and appendages; genitalia and their modifications.

Unit 3: 5L

1. Structure and function of – the visual organs, the sense organs and the effector organs in insect.

Unit 4: Insect diversity and ecology 15L

1. Abundance and diversity of insects; reasons for success. Basic principles of abiotic factors and their generalized action on insects. Biotic factors – food as a limiting factor for distribution and abundance; 2. Life tables and their application to insect biology. Survivorship curves. Population dynamics – factors effecting abundance; environmental factors, dispersal and migration; 3. Insect plant interaction; host plant selection by phytophagous insects, signs of damage caused by forest insects.

Unit 5 : Medical entomology 7L

1. Insect of medical importance (Life cycle and control) – Mosquitoes (Aedes, Anopheles, Culex); flies (housefly, horsefly, tsetse fly and sandfly); 2. Study of viral diseases – Dengue, Malaria, Kala-azar, Japanese Encephalitis, chikungunya, zika; 3. Insect in forensic science.

PRACTICAL: Credit- 2

1. Mounting of mouth parts of mosquito, cockroach, butterfly and honey bee
2. Mounting of legs, antennae and wings (at least of two types)

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3. Preparation of arolium, empodium, tentorium and pollen basket.
4. Identification of medically important insects.
5. Study of insect collecting devices.
6. Study of methods of insect collection and preservation.
7. Field visit to Agricultural field/Wild life institute/National Park/Forensic lab visit and submission of field report.
8. Practical record book.
9. Viva voce.

Books Recommended

1. *A general text book of entomology*, Imms , A. D., Chapman and 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. *Principles of Insect Morphology*, Snodgrass, R. E., Cornell Univ. Press, USA
4. *Host Selection by Phytophagous insects*, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
5. *Insect Plant Biology*, Schoonhoven, L. M., van Loop, J. A., & Dicke. M. Pub. Oxford Univ. Press. USA
6. *Insects: Structure and Function*. Chapman RF. 1998. ELBS Ed., London.
7. *The Insects: Structure, Function and Biodiversity*. Duntson PA. 2004. Kalyani Publ., New Delhi.
8. *Physiology of Insects*. Patnaik BD. 2002. Dominant, New Delhi.
9. *Entomology*. 10th Ed. Vol. 1. *Structure, Physiology and Development*. Chapman & Hall, New York.
10. *Entomology at a Glance*. Saxena RC & Srivastava RC. 2007 Agrotech Publ. Academy, Jodhpur.
11. *Ecology: Principles & Applications*. 2nd Ed. Chapman JL & Reiss MJ. 2006. Cambridge Univ. Press, Cambridge.
12. *Advances in Insect Biodiversity*. Gupta RK. 2004. Agrobios, Jodhpur.
13. *Insect Ecology*. 3rd Ed. Price PW. 1997. John Wiley, New York.
14. *Ecology of Insects: Concepts and Application*. Speight MR, Hunta MD & Watt AD. 2006. Elsevier Science Publ., The Netherlands.
15. *Modern entomology* 2014. Thembrae DB, Himalayan Publishing House
16. *Biology of Disease Vectors*, 2nd Ed; Marquardt WC, 2004, Elsevier Academic press
17. *Medical entomology : A textbook on Public Health and Veterinary Problems Caused by Arthropods*, Revised Edition, Edited by Bruce Eldridge and John Edman
18. *Medical and Veterinary Entomology* Mullen, G., Durden, L., A.

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PAPER: ZOO905S

FISH BIOLOGY AND FISHERY SCIENCE– I
(Credits: 3+0+2=5)

(TAXONOMY, ANATOMY, PHYSIOLOGY AND OSTEOLOGY, AQUACULTURE)

Unit 1. Taxonomy (5L)

1. Taxonomic characterisation, taxonomic keys, taxonomic methods for identification of freshwater teleosts, 2. Molecular taxonomy in fishes.

Unit 2. Anatomy, Physiology and Osteology 11L

1. Overview of external and internal fish anatomy, Major anatomical features of different types of fishes, 2. Sensory and related anatomical features of fishes, 3. Skin, Scale and Fins of freshwater fishes, 4. Digestion: digestive system and feeding types in fish, 5. Respiration: Structure and function of gills, accessory respiratory organs, 6. Excretion: Kidney: structure and function, osmoregulation in freshwater and marine teleost, 7. Reproduction and development of teleost, 8. Osteological study of skull, pectoral and pelvic girdle, vertebral column of freshwater teleost.

Unit 3. Aquaculture I 16L

1. Scopes of aquaculture including fisheries, 2. Types of aquaculture (warm and cold water), aquaculture systems (monoculture, polyculture, semi-intensive, intensive culture, monosex culture), 3. Fish breeding technology (induced, hatchery, hapa, bundh breeding and stripping) and its importance, 4. Integrated fish farming (paddy cum fish, duck cum fish, pig cum fish, fish cum livesock), 5. Composite fish farming: methods and importance, 6. Culture of ornamental fishes (exotic and indigenous) and their importance., 7. Aquatic weeds, 8. Larvivorous fishes, 9. Threatened and endemic fishes of Northeast India with special reference to Assam, 10. Fish genetic diversity, conservation methods and strategies.

Unit 4. Aquaculture II 16L

1. Types of capture fishery resources, 2. Fishery resources in major river systems of India with special reference to Brahmaputra and Barak river system, 3. Hill stream fisheries: Mahaseer fisheries, 4. Flood plain wetland (beel) fisheries of Assam, their problems and management, 5. Fundamentals of marine fisheries (Sardine and Meckerals), 6. Fishing gears in inland fisheries and fishing crafts in marine fisheries., 7. Migration of fish, 8. Sewage fed fisheries, 9. By-products of fish, 10. Transportation of fish seed and fishes, 11. Principle and practice of fish preservation, processing and care.

PRACTICAL: Credit- 2

1. Morphometric and meristic analysis of teleost.
2. Study of skeletal system of freshwater fishes.
3. Dissections: Accessory respiratory system of *Anabas* sp., *Channa* sp. and *Heteropneustes fossilis*. Urino-genital system of carp, Weberian ossicles of carp, IXth and Xth cranial nerves in carps.

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4. Induced breeding techniques of IMC.
5. Identification of ornamental fishes of freshwater with reasons up to order.
6. Identification of freshwater exotic fishes with reasons up to order.
7. Identification of fishes of the river Brahmaputra with reasons up to order.
8. Identification of marine water fishes.
9. Study of fishing gears used in Assam.
10. Submission of fish specimens representing different groups (at least 10 numbers).
11. Submission of fish skeleton representing different groups.
12. Visit to fish farm, wetlands within Assam.

(Open Elective)

PAPER: ZOO906P

GENERAL TOXICOLOGY– I

(Credits: 3+0+1=4)

Unit1: INTRODUCTION TO TOXICOLOGY (11L)

1. Definition, Scope and sub division of toxicology. 2. Classification of toxic agents, 3. Dose, Dose effect and Dose response relationship – Acute toxicity and Chronic Toxicity. 4. Factors affecting toxicity 5. Absorption and Distribution of toxicants

UNIT 2: BIOCHEMICAL TOXICOLOGY 10L

2.1. Mechanism of toxicity

1. Reaction of toxicants with target molecules 2. Cellular disrepair and repair mechanisms. 3. Lipid peroxidation– ROS and RNS, Superoxide, Hydrogen Peroxide and Hydroxyl radicals in toxicity of Xenobiotics. 4. Oxidative Stress, 5. Xenobiotic induced alterations in intracellular calcium distribution, disruption of cellular energy production. 6. Introduction to Phase I and II reactions. 31

Unit 3: SYSTEMIC TOXICOLOGY 12L

3.1 Basics of Organ toxicity

1. Target organs, Organ selectivity and specificity. 2. Hepatotoxicity- susceptibility of the Liver, types of Liver injury and Biochemical mechanism. 3. Pulmonary toxicity – Lung injury, Systemic Lung toxins, Lung pathology. 4. Renal toxicity – susceptibility of the Kidney to toxicants, Chemical induced renal injury. 5. Neurotoxicity – Effect of toxic agents on Neurons, Axonopathy, Myelionopathy, ion channel, neurotoxins, Lesions of specific neurons.

Unit 4: SYSTEMIC TOXICOLOGY AND CHEMICAL CARCINOGENESIS (15L)

4.1 Reproductive Toxicology : 4L

1. Reproductive organs, Chemicals affecting reproduction 2. Teratogenicity.

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4.2 Endocrine toxicology : 3L

1.Toxicity of Adrenal, 2. Thyroid and 3. Pancreas.

4.3 Bio-magnification, bio-transformation of xenobiotics

4.4 Genotoxicity: 4L

1. DNA interaction, 2. DNA adducts and Mutations 3. DNA repair

4.5 Carcinogenesis: 4L

1.Types of carcinogens 2. Mechanisms of action.

PRACTICAL: (All experiments involving live animals are for demonstration only) Credit:1

1. Determination of LC50/LD50 of selected toxicant (bioassay method)
2. Effect of selected toxicant on Phase I enzyme activity (Cyt P450) (enzymatic assay)
3. Estimation of LPO activity by TBRAS method
4. Effect of toxicant on Glycogen, Glucose and Amino acids
5. Hepato-toxicant effect on Total Bilirubin Content (direct and indirect method)
6. Estimation of SGOT and SGPT as a marker enzyme for hepatotoxicity
7. Estimation of Serum Creatinine activity as a marker enzyme for Renal toxicity
8. Micronuclei test
9. Effect of toxicant on sperm morphology

Recomended Books:

1. Principles of ecotoxicology- 3rd edition 2006, C H Walker, S P Hopkin, R N Sibly and D BPeakall (Eds.), Taylor and Francis, NewYork, NY.
2. Introduction to Environmental toxicology -3rd edition 2003, W.G.Landis and M.H.Yu.Lewis publishers, Florida.
3. Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patrica Levi, McGraw –Hill International edition. Singapore.
4. Principles of toxicology 2010 edition, Anju Agarwal and Krishna Gopal, ibdc publishersIndia.
5. Essentials of Toxicology 2011 edition, Vijay Kumar Matham, New India Publishing Agency,New Delhi, India.
6. Principles of Biochemical Toxicology- Jatimbrell; Taylor and Francis Ltd, London.

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7. Basic Environmental Toxicology – LorrisG.Cockerham, Barbara S Shane; CRC Press,London.

8. Hand book of Toxicology – Thomos J Haley, Willan O Berndt; Hemisphere Publishingcooperation, Washington.

9. Modern Toxicology (3 Volumes) - P K Gupta and Salunkha; B V Gupta Metropolitan BookCo., Ptv Ltd, New Delhi.

10. Encyclopedia of Toxicology – O P Jasra.
