MANGALORE UNIVERSITY

APPLIED ZOOLOGY

SYLLABUS
PH.D. COURSE WORK

2011-12

DEPARTMENT OF APPLIED ZOOLOGY
MANGALORE UNIVERSITY
MANGALAGANGOTHRI - 574 199.

MANGALORE UNIVERSITY
APPLIED ZOOLOGY
PH.D.COURSE WORK

Scheme of Course Work

Papers	Particulars	Hours of Instruction per week	Duration of Examination (hrs)	Marks			Credits
				IA	Theory	Total	
Paper 1	Research Methodology	4	3	30	70	100	4
Paper 2	Theoretical Foundations	4	3	30	70	100	4
Paper 3	Recent Developments	4	3	30	70	100	4
Paper 4	Reviewing of Literature and Planning of the Proposed Research Work with a Tentative Title	4	-	-	-	200	8
		Total 16					20 Credits

IA = Internal assessment

Note: Internal assessment will be based on , 1 theory test, 1 Objective test and Seminar/ assignment in each paper.

Pattern of question paper for theory examination of 70 marks:

Q.no.I - 10 questions of 2 marks each 10X2 = 20
(Two questions need to be chosen from each unit)

Q. no. II to VI - 10 marks each 5X10 = 50

TOTAL : 70

2 questions need to be given from each unit and candidate shall answer one question out of them. The choice shall be within the unit only.

Dr. K.K. Vijayalaxmi
Chairperson
Board of Studies in Applied Zoology

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APPLIED ZOOLOGY
PH.D. COURSE WORK

PAPER I :RESEARCH METHODOLOGY

12 hours/unit Total : 60 hrs.

Unit I - ***Research Planning and Execution***

Defining of research problem, objectives and its importance.
Sources of information; Journals, books, Biological abstracts, Reviews.
Data bases, search engines, INFLIBNET, Pubmed, Science Direct, e journals, Bibliography.
Background, preliminary observations; Data collection, Recording the data, Methods of analysis, presentation of the data.
Methods of writing the findings; components of thesis, Structure of a research article, Presentation of research findings

Unit II - ***Biostatistics and Computer applications***

Statistical variables, Frequency distribution, Graphical representation of the data.
Probability, ANOVA , Student *t* test; Chi square test, Correlation and regression analysis; Nonparametric tests – Wilcoxon signed rank test, Mann-Whitney U Test, Kruskel Wallis test.
Computer software statistical packages, MS EXCEL, SPSS, MINITAB Packages and their uses.
Dun net's post-hoc test.

Unit III - ***Cell and Molecular Biologytechniques***

In vitro animal cell culture systems, Primary and secondary cultures, requirements, methodology and applications of each culture systems.
Principle, methods and applications of Cryopreservation, Histological and Histochemical techniques, flow cytometry
Principle, methods and applications of light and confocal microscopy, Electron microscopy.

Image analysis, Gel doc system – Methods and applications.
Principle, methods and applications of Polymerase chain reaction, DNA sequencing, Blot techniques
Autoradiography, DNA fingerprinting, FISH, RFLP– Principle, methods and applications

Unit IV -***Biochemical and physiology techniques***

Principle, methods and applications of various types of Chromatography; HPLC, GLC, LCMS
Dialysis and precipitation technique; Ultracentrifugation Electrophoresis, Electrofocussing, organelle separation- Principle, methods and applications.

Principle, methods and applications of Spectrophotometry, Tracer techniques, ELISA, RIA, Immunodiffussion and immunoprecipitation.
Electrodes, preamplifiers, DC and AC, Faraday cage oscilloscopy, Analog-digital convertion, Anatomical studies: use of antibodies, GFP Gal 4 lines

Unit V - ***Breeding andmaintenance of laboratory animals***

Introduction to experimental animals- mouse, rats, guinea pigs, hamsters, rabbits.
Breeding and maintenance of small laboratory animals – mouse and rat
CPCSEA Guidelines and IAEC – Rules and regulations for animal breeding and maintenance.
Handling, treatment and collection of biological materials from experimental animals, Good laboratory practices
Waste disposal

References:

1. Beaven, C.R. Hand book of the Freshwater Fishes of India. Narendra's Pub.House, New Delhi
2. Celis J. E., (1994): Cell Biology – a laboratory hand book, Vol.I, II and III, Academic press.
3. Freshney R. I. (2000&2005) Culture of animal cells: A manual of basic technique, IV&V Edition, Alan R. Liss, Inc. New York.
4. Fox J. G. and Cohen B. J. (Ed) (1984) Laboratory animal in medicine, Academic press Inc.,
5. Gurmani N. (2004) An Introduction to Biostatistics, MJP publishers, Chennai.
6. Jayaraman, K.C. (1981) The Freshwater Fishes of India – A Hand book. Sri.
7. Kleinsmith L. J. and Kish V. M (1995) Principles of Cell and Molecular Biology, II edition, Harper Collins College publishers.
8. Hassard T.H. 1991) Understanding Biostat. Mosby year book, London
9. Hawkins C. and M. Sorgi (Eds)(1985) Research how to plan, speak and write about it, Springer-Verlag; Hiedelberg.
10. Philip, Sheeler (1987) Cell and Molecular Biology, III edition, John Wiley New York.
11. Potts, G.W. and R.I. Wootton(1984) Fish reproduction strategies and tactics. Academic press, pp 249-331.
12. MaciefowshiJ.andZieba J. (1982) Genetics and animal breeding, Elsevier – Scientific publishing company, Poland.

13. Norman T. J. Bailey (1994) Statistical methods in biology, 3rd edition, Cambridge University Press.

14. Poole T. B. and Robinson R. (Ed) (1987) The UFAW handbook on the care and management of laboratory animals, VI edition, Longman scientific and technical. and IBH publishing Co, Pvt. Ltd., New Delhi.

15. Prakash M., C. K. Arora (1998) Laboratory animals, encyclopedia of laboratory technique, Anmol Publication, New Delhi. edition, Prentice Hall, New Jersey.

APPLIED ZOOLOGY
PH.D. COURSE WORK
PAPER II- THEORETICAL FOUNDATION

12 hrs/unit **Total - 60 hours**

Unit ICell and Molecular Biology and Cancer Biology

Organisation of prokaryotic and eukaryotic cells. Animal viruses, bacterial viruses, plant viruses.

Structural organization of nucleus, structure of eukaryotic chromosomes. Molecular organization of chromatin, Nucleosomes. Structure of gene, genetic code and gene regulation.

DNA structure, mutations, DNA repair.

Type of cancer, causes of cancer, cancer inducing agents. Occupational cancers, Role of tobacco as carcinogenic agent.

Chromosomal changes in cancer. Oncogenes and tumer suppresser genes; their role in carcinogenises. Cellular ageing, apoptosis.

Unit II Genetics and Cytogenetics :

Cell cycle, Mitosis, Meiosis - Gametogenesis. Physical basis of heredity. Perspective of Human Genetics- Human chromosomes and construction of karyotype. Chromosome non-disjunction. Chromosomal aberrations- Structural and numerical chromosome variations; chromosomal races. Autosomal and sex linked chromosomal inheritance, Multifactorial inheritance, Pedigree analysis . Genetic counseling. Amniocentesis, chorionic villus sampling. IVF in humans.

Unit III Physiology and Neurobiology

Concept of homeostasis. Variables-External factors and internal milieu. Mechanisms of homeostasis, range and control systems. Transport of ions and molecules through the cell Membrane. Intracellular communication and pathways. Contraction and excitation of skeletal muscles, neuromuscular transmission and coupling. Electrocardiogram and dynamics of circulation.Structure of nervous system. Electrical activity of neurons. Regulation of blood volume, extracellular fluid volume and acid- base balance. Digestion and absorption in the GI tract.

Unit IV Biodiversity

Biodiversity and its importance –Values of biodiversity. Uniqueness of Indian wildlife. Types of Ecosystem- Aquatic, terrestrial and Nature of ecosystem . Species interactions , Keystone species . Energy flow in ecosystem, Loss of biodiversity- Natural and Anthropogenic factors . Principles and methods of Conservation – In situ and Ex- situ conservation .Biodiversity indices .

Unit :V Entomology and Fishery Biology MK,

Entomology -Classification of insects, General morphology of insects- Pests of major field and horticultural crops. Storage pests, Vectors of human diseases, beneficial insects.

Fishery Biology - Introduction, Classification of fishes with special reference to evolutionary trends and adaptations. Distribution of freshwater and marine fishes of India. Food and feeding habits of fishes (general account);Reproduction- Reproductive diversity, Reproductive cycles, Reproduction and spawning; fish eggs and larvae, Reproductive behavior and parental care.

References:

1. Archana Sharma, Geeta Talukder, S K Mukherjee(1983) Methods in human genetics, Kalyani Publishers, New Delhi.

2. Beaven, C.R. Hand book of the Freshwater Fishes of India. Narendra's Pub.House, New Delhi

3. Cummings S. (Ed.) (2000) Current Perspectives in Genetics, Brooks/Cole, London

4. Guyton A.C. and Hall J. E. (2006) Text book of Medical Physiology , Elsevier Saunders, Pensylvania

5. Kleinsmith L. J. and Kish V. M (1995) Principles of Cell and Molecular Biology, II edition, Harper Collins College publishers

6. Mange E.J. and A.P. Mange (1994) Basic human genetics, Rastogi Publications, Meerut , India.

7. Marcus A. (2010) Human Genetics, an overview, Narosa New Delhi

8. Mark F. Bear ,Barry W. ConnorsMichael A. Paradiso, 2007, Neuroscience: Exploring the Brain , Academic Press

9. Raymond W. R (2007) Cancer Biology, Oxford University Press, New York.

10. Vasantharaj David, B and Kumar Swamy, T. Elements of Economic Entomology. Popular Book Depot. Chennai.

Changed version

APPLIED ZOOLOGY
Ph.D. Course Work

Paper III : Recent Developments

Genetic toxicology and Carcinogenesis

12 Hrs. /Unit **Total hours: 60**

Unit I - Basic concepts of mutagenesis and genetic toxicology.

Introduction and historical perspective, Genotoxic exposures and DNA alternations – A classification scheme for genotoxic effects, microlesions and macrolesions, chromosomal aberration and gene mutations. Significance of genotoxic effects.
Risk estimation- definition of risk estimation, risk estimation in somatic and germ cells, dosimetry issues in risk assessment, data extrapolation issues in risk analysis.
Relationship of genotoxic effects to other toxicological phenomenon – oncogenesis, teratogenesis, sterility, aging etc.

Unit II – Basic concepts of cancer biology and carcinogenesis

What is cancer? Definition and description of cancer, How cancer arises? Basic facts about cancer, Hallmarks of malignant diseases.
Classification of human cancers, benign, malignant and metastatic tumors. Characteristics of malignant cells, grade and stage of neoplasms. Steps involved in carcinogenesis process, initiation, promotion and progression.
Tumor immunology - mechanisms of the immune response to cancer, tumor antigens.
Alterations seen in transformed cells in culture, cancer cell lines, maintenance of cancer cell lines in the laboratory. Cytogenetic changes in cancer, telomere and telomerase activity.

Unit III – Genotoxicity and carcinogenicity in humans and other mammals

Effect of mutagens on somatic and germinal cells of human and other mammals.
Mutagenic and clastogenic effects of radiation and chemicals in humans and experimental animals. Occupation related mutagens.

Cancer inducing agents - Physical, chemical and biological agents, types of chemical carcinogens and mechanism of their actions. Irradiation carcinogenesis- Ionizing radiation, ultraviolet radiation, and mechanism of their action. Viral carcinogenesis - Role of viruses in the causation of human cancers.
Environmental causes of cancer, occupation related cancers, Role of tobacco in cancer induction, Carcinogens in the food.
Role of oncogenes and tumor suppressor genes in cancer induction, mechanism of their activation.

Unit IV - Genotoxicity testing methods and evaluation

Cytogenetic tests in mammals- treatment protocol, preparation of bone marrow chromosomes in mouse and aberration analysis. Bone marrow micronucleus tests and

tranplacental micronucleus tests. Cytogenetic & Genetic assays with germinal cells, meiotic chromosome aberration, sperm shape abnormality assay, dominant lethal test.

Assays for the detection of chromosome aberrations and micronuclei in cultured mammalian cells, MN test in binucleate cells, *In vivo* and *in vitro* comet assays.

Mutagenecity assays in bacterial cells- Ame's test,

Strategies for building a test battery, specific approaches, conducting the tests- general criteria for dose selection, *in vivo* and *in vitro* testing, data analysis and interpretation, interpretation of results from test batteries.

Unit V - Antimutagenesis and anticarcinogenesis

Definition of antimutagens and anticlastogens. Test systems for antimutagencity and anticlastongencity studies. Mammalian *in vivo* and *in vitro* test systems. Protocol for the anticlastogencity testing in mice and cultured lymphocytes. Antimutagencity/ anticlastogenecity/anticarcinogenecity of plant extracts, seaweeds, vitamins and other natural compounds.

Mechanism of inhihibitors of mutagenesis and carcinogenesis - classification and overview. Chemoprevention, radiomodifiers and radiosensitisers. *Invivo* survival assays, MST, ILS, trypan blue dye exclusion test, IC 50, MTT assay, apoptotic assays for anticarcinogenecity studies.

Formation of Oxygen-free radicals in toxic exposures and cancers, Role of antioxidants in antimutagenesis and anticarcinogenesis - SOD, catalase, GSH, GST , glutathione peroxidase, lipid peroxidation.

References:

1. Auerbach C. (1976) Mutation Research, problems, results and perspectives, Chapman and Hall, London.
2. Becker F. F (Ed) (1975) Cancer, Vol.1-3, Plenum Press, New York.
3. Bhattacharjee D., and Singh B.B.(Eds) (1995) Radiobiological concepts in radiotherapy, Narosa Publishing House, New Delhi.
4. Bronzetti G., H. Hayatsu, S. De Flora, M.D. Waters and D.M. Shankel(Eds.), (1993)Antimutagenesis and anticarcinogenesis, Mechanisms III, Plenum Press, New York.
5. Brusick D. J. (1987) Principles of genetic toxiclogy, II edition, Plenum Press,New York.
6. Christopher, M. T. and Paul, J. M. (2000) Mutagenesis and Genetic Toxicology, Principles of Toxicology- environmental and industrial application, 2nd edition, Wiley-Interscience Publication, New York.
7. Committee on Chemical Environmental Mutagens (1983)Identifying andestimating the genetic impact of chemical mutagens, National Academy Press, Washington D.C.
8. Fishbein L.W., G. Flam and H.L. Falk (1970) Chemical mutagens, environmental effects on biological systems, Academic Press, Newyork.
9. Gebhart, E. and Arutyunyan, M. E. (1991) Anticlastogens in Mammalian and Human Cells, Springer-Verlag Berlin and Heidelberg GmbH & Co.
10. Heim S, Mitelman F (1987) Cancer Cytogenetics, Alan R. Liss, Inc., New York.
11. HollaenderA.(Ed) (1971, 1976, 1978, 1982) Chemical mutagens, principles and methods for their detection. Vol. 1 - vol. 5, Plenum press, New York.
12. J.A. Heddle (Ed.) (1982) Mutagenecity, new horizons in genetic toxicology, Academic press.
13. Kappas A. (Ed) (1981) Progress in Environmental Mutagenesis and Carcinogenesis, Elsevier/ North Holland Biomedical Press, Oxford.

14. Kihlman B.A. (1977) Caffeine and chromosomes, Elsevier North Holland, New York.
15. Kleinsmith L. J. and Valeri M. K. (1995) Principles of Cell and Molecular Biology, II edition, Harper Collins College publishers.
16. Raymond W. R (2007) Cancer Biology, Oxford University Press, New York.
17. Raymond W. R (1981) Cancer Biology, Oxford University Press, New York.

18. Souhani R (1986) Cancer and its management, Blackwell Publishers, Oxford.
19. S. Venitt and J.M.Parry (Eds.), Cytogenetic tests in mammals, In: Mutagenicity Testing – A Practical Approach, IRL Press Ltd., Oxford, England,
20. Uma Devi P., K.S. Bisht, B.SS. Rao (Eds) (1997) Radiation, Radiomodifiesand Human Health, I edition, National Inst. Of Science communication India.
21. Watson R.R. and Mufti S.I.(Eds) (1996) Nutrition and Cancer prevention, CRC press, New York.

Important Journals

1. Mutagenesis, Oxford Journal.
2. Environmental and Molecular Mutagenesis, Wiley Journal
3. Mutation Research - Fundamental and Molecular Mechanisms of Mutagenesis , Elsevier
4. Mutation Research - Genetic Toxicology and Environmental Mutagenesis, Elsevier.
5. Mutation Research - Reviews in Mutation Research
6. Mutation Research, DNA Repair, Elsevier.
7. Environmental toxicology and pharmacology
8. Journal of Ethnopharmacology, Elsevier
9. Cancer letters.
10. Nutrition and cancer.
11. Carcinogenesis.
12. Cancer Biology.
13. Environmental toxicology and pharmacology
14. Phytotherapea

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APPLIED ZOOLOGY
Ph.D. Course Work

Paper III : Recent Developments

Neurobiology

12 hrs/unit **Total - 60 hours**

Unit I. Development of the nervous system

- Neuronal induction
- Cellular determination
- Neurogenesis and migration
- Growth cones, Axon pathfinding, Synapse elimination

Unit II. Neurotransmitters

- Synthesis and release of neurotransmitters
- Neurotransmitter receptors
- Post synaptic potentials
- Synpatic integration and modulation

Unit III. Ion channels

- Ion channel families
- Gating of ion channels
- Ion permeation
- Venoms and drugs acting on ion channels.

Unit IV. Neuronal plasticity

- Molecular aspects of plasticity
- Genetic approaches to learning and memory
- Long term potentiation
- Disorders of learning memory

Unit V. Sociobiology

- Social organization
- Costs and benefits of social life
- Inclusive fitness
- Evolution of eusocial behaviour

References:

1. Development of the Nervous System, 3rd Edition , 2005, Academic PressDan H. Sanes, Thomas A. Reh & William A. Harris

2. Fundamental Neuroscience, Second Edition , 2008, Academic PressLarry R. Squire, James L. Roberts, Nicholas C. Spitzer, Michael J. Zigmond, Susan K. McConnell, Floyd E. Bloom
3. From molecules to networks, 2004, Elsevier, John H Byrne, James L Roberts
4. Gene Expression to Neurobiology and Behaviour Volume 189, 2006, Academic Press Oliver Braddick, Janette Atkinson and Giorgio M. Innocenti
5. Neuroscience: Exploring the Brain , 2007, Academic Press, Mark F. Bear ,Barry W. ConnorsMichael A. Paradiso
6. Psychological Science , 2009, Academic Press, Michael S. Gazzaniga, Diane F. Halpern and Todd F. Heatherton
7. The Human Brain: Essentials of Behavioral Neuroscience, 2007, Academic Press, Dr. Jackson Beatty

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APPLIED ZOOLOGY
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Paper III : Recent Developments
PHYSIOLOGY

12 hrs/unit **Total - 60 hours**

Unit I The matrix and energetics of life

Diffusion, surface tension and viscosity- their characteristics, factors influencing and biological application. Osmosis: osmotic pressure- laws. Role of water in biological processes, structure and properties of water, Protolysis of water. pH, acid-base neutralization curves, Buffer action: Henderson- Hasselbalch equation. Regulation of pH by blood buffers. Molecules with multiple ionizing groups. Thermodynamics: Type of surroundings and systems. First Law- Internal energy, enthalpy. Second law-Entropy, Free energy change, High energy phosphate compounds as energy shuttles, Endergonic and Exergonic reactions, Reversible and Irreversible processes, Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system..

Unit II Enzymes - Biological Catalysts

Role of enzymes, Chemical reaction rates and the effects of catalysts, Classification-EC nomenclature, Enzymes as catalysts, Kinetics of enzymatic catalysts, Enzyme inhibition, Concept of apoenzyme, holoenzyme, coenzyme, cofactors and prosthetic groups. Diversity of enzymatic function, Non-protein biocatalyst-ribozymes, Rate-limiting enzymes, Isozymes, Ribozymes and Abzymes. Regulation of enzyme activity. Covalent modifications used to regulate enzyme activity. Molecular engineering of new and modified enzymes.

Unit III Gastrointestinal Physiology

Anatomy and Histology of alimentary canal. Principles of gastrointestinal function, Transport and mixing of food, Secretory functions, Digestion and absorption in the GI tract, Gastrointestinal disorders-peptic ulcer, constipation, diarrhea, vomiting, nausea, Gastrointestinal obstruction, Gases in the GI tract and flatus.

Unit IV . N**europhysiology**

Structure, classification and functions of neurons and neuroglias, Cytoskeletal elements and axoplasmic flow, Myelinogenesis, Resting membrane potential, the action potential, electrotonic potentials, current of injury, Propagation of nerve impulse in different types of nerve fibres, Compound action potential, Properties of nerve fibres, Chronaxie, rheobase and utilization time, synapses-types, structure, synaptic transmission of nerve impulse, synaptic potentials, neurotransmitters, cotransmitters and neuromodulators, Neuromuscular junction, structure, transmission, end-plate potential, MEPP, post titanic potentiation, Motor unit and motor point, Injury to peripheral nerves-degeneration and regeneration in nerve fibre, changes in nerve cell body, Thermal changes of nerve during activityand nerve growth factors.

Unit V Muscle Physiology

Microscopic anatomy of a muscle fibre and motor unit., Skeletal muscle contraction at the molecular level, Histochemistry to determine the properties of muscle fibers. The muscle twitch, Stimulus strength and muscle contraction. Stimulus frequency and muscle contractions. Factors affecting force, velocity and duration of muscle contraction.

Electromyogram. Types of muscle contraction, Physiological contracture and muscle rigor mortis. Energy sources of muscle contraction

References:

1. Byrne J. H. and Roberts J. L. (2004) From Molecules to Networks – an introduction to Cellular and Molecular Neuroscience, Academic Press, California.
2. Guyton A.C. and Hall J. E. (2006) Text book of Medical Physiology , Elsevier Saunders, Pensylvania
3. Mathews C. K., van Holde K. E. and Ahern K. G., (2005) Biochemistry III edn. Pearson Education, New Delhi.
4. Moyes C. D. And Schulte P. M. (2008) Principles of Animal Physiology II edn. Pearson Education Inc. San Francisco
5. Squire R. L., Berg D., Bloom F., Lac S., Ghosh A., and Spitzer N., (2008) Fundamental Neuroscience, Academic Press, Burlington.

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APPLIED ZOOLOGY
PH.D. COURSE WORK

PAPER III : RECENT DEVELOPMENTS
BIODIVERSITY

12 hours / Unit **Total – 60 Hrs.**

UNIT I - BIODIVERSITY ASSESSEMENT:
Biodiversity; Distribution of biodiversity in India and at Global level. genetic diversity, molecular diversity and taxonomy, , DNA bar-coding, Modern tools of Taxonomy (alpha, beta and gamma level taxonomy), Application of molecular and computational tools for phylogeny - Quantitative methods: Biostatistics used for analysis of data ; Computer databases and their applications.

UNIT –II INVENTORYING AND MONITORING BIODIVERSITY :
Field studies: Assessment of biodiversity in different types of ecosystems, sampling techniques and quantitative methods for biodiversity assessment. Demographic analysis,. Techniques for capturing Wild animals . Tools and techniques in data collection and management. Taxon data sheet. GIS and GPS system. Resource base - Reference collection- Zoo, Botanical Garden , Aquaria etc. Gene bank, Sequence data bank.

UNIT III - THREATS AND STATUS OF BIODIVERSITY :
Mass extinction and global climatic change. Species extinction. Effects of man made alteration on biosphere . Biodiversity Hot spots. Intra and Inter specific Competition, Diseases of Wild animals. Climate change- Greenhouse effect. Global warming. ioaccumulationand Biomagnifications. IUCN red list criteria and categories.

UNIT IV - BIODIVERSITY CONSERVATION :
Identification of priority areas in biodiversity conservation. Managing ecosystem- Establishment of wildlife corridor. Management of wildlife population- .Habitat management and conservations. In-situ conservation: establishment of protected areas- National parks & Sanctuaries. Ex-situ conservation: Captive breeding and repopulation program.

UNIT V – BIODIVERSITY LEGISLATION AND SPECIAL PROJECTS
Legal aspects- National and International conventions- CITES, TRAFFIC; Earth summits, Ramsar convenventions, Wildlife laws- Wildlife (protection) Act-1972; Indian biodiversity laws; Biodiversity acts, Forest laws of India, Fisheries act, Special projects- Project Tiger, Gir Lion project, Project Elephant, Crocodile breeding project.

References :

1. Heywood V.H. and Watson R.T. (1995). Global biodiversity assessment. UNEP programme. Cambridge Univ. press, Cambridge.
2. Hassard T.H. (1991). Understanding biostatistics . Mosby year Book St.Louis.
3. Khan, I.A. and Khanum A. (1994) . Fundamentals of biostatistics .UkaazPubl.AP.
4. Perrrings , C.A. (1995) .Biodiversity conservation. KulwerAcademic Publ. Netherlands.
5. Perlman D. L. and Adelson G. (1997). Biodiversity : Exploring values and priorities in Conservation. Blackwell Sciences, USA
6. Maczulak, A. (2010) .Biodiversity : Conserving endangered species. Facts on file. Inc. USA.

7. Michener , W.K. and Blunt J.W. (2000) . Ecological data: design , management and processing . Blackwell Publ. USA

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PAPER III : RECENT DEVELOPMENTS

CYTOGENETICS

12 hours / Unit **Total – 60 Hrs.**

UNIT I : **Chromosomes in evolutionary process**
Chromosomes in karyotype changes & species differentiation, chromosomal mechanics in speciation processes (Rodents, Insects), Polytene chromosome polymorphism in Dipteran examples. Role of heterochromotin in species evolution& Karyotypic differentiation. Chromosome instability and fragile sites.

UNIT II : **Human Clinical Cytogenetics and Prenatal Diagnosis :**
Human blood group genetics – inheritance pattern ; Dermatoglyphics. Heritable chromosomal abnormalities-Disorders of autosomes, Disorders of sex chromosomes, chromosome breakage syndromes. Amniocentesis, Chorionic villi biopsy, Cytogenetics of prenatal chromosomal abnormalities with clinical citations, Transplantation changes in bone marrow, Peripheral stem cells & Umbilical cord cells with chromosomal features.

UNIT III : **Cytogenetic techniques:**
Cell lines, Cell & Tissue culture practices, Harvesting of cells for chromosomal analysis, conventional& specialized staining protocols, Meiotic chromosome analysis, mitotic chromosome analysis. Chromosomal banding techniques : G-, C-, R-, Q- and NOR staining, CO-FISH staining of chromosomes. Chromosome painting. Construction of phylogenetic tree- Distance method, Parsimony, maximum – likelihood method.

UNIT IV : **Molecular genetic techniques**
Methods of DNA analysis, Diagnosing infectious diseases, Identifying genetic disease . PCR-DNA sequence analysis; Mitochondrial DNA Studies on population Genetics. FISH and spectral karyotyping ,imaging in cytogenetic practices. Medical forensics:DNA fingerprinting, - genetic identification, Use of technology in anthropological studies . Molecular phylogenetics

UNIT V : **Molecular diagnostics and therapy**
Genomics and Proteomics: Genome mapping- Genetic mapping, Physical mapping, Resolution of mapping : Comparative Genomics ; microarray analysis and their applications. Importance of proteomics . Database and search engines in proteomics ; Understanding mechanism of pathogenesis, Drug discovery, Disease diagnosis, identification and characterization of novel proteins. Gene therapy: vectors in gene therapy, advances in gene therapy, safety assurances.

References :

1. Atherly., A.G., Girton, J.R., and Mcdonald J.F. (1990) . The Sciences of Genetics .Saunders College Publ. USA
2. Connor J.M. and Smith M.A.F. (1987). Essential Medical genetics. II eds. Blackwell Publ. USA
3. Fraser C.F. and Nora J.J. (1986). Genetics of Man II Eds. Lee and Febiger Publ. Philadelphia
4. Lewin B. (2006) : Essential Genes. Pearson Education .Inc. NJ

5. Lodish H. Berk, A. Matsudaira P et al. (2004). Molecular cell biology. W.H. Freeman and Comp. NY
6. Macgregor H.C. (1993) An introduction to animal cytogentics. Chapman and Hall, Oxford.
7. Popescu .P , Hayes ,H. and Dutrillaux B. (1998) .Techniques in animal cytogenetics . Springer Verlag, Germany.

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APPLIED ZOOLOGY
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Paper III- Recent Developments

Entomology

12 hours per unit **Total 60 hrs**

Unit I Economic entomology
Biosystematics, morphology of insects-
Pests of major field and horticultural crops.
Storage pests, human disease carriers
Beneficial insects *viz*., honeybees, silkworms, lac insect and pollinator
Vectors of plant diseases

Unit II Toxicology
Insecticides- Classification- Mode of entry and action- toxicity- handling
Chemistry-Chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, neonicotinoids, insect growth regulators, botanicals, biorationals
Insecticides with novel mode of action
Resistance, resurgence, secondary pest outbreak, residue and insecticide resistance management, insecticide metabolism and decontamination

Unit II Host Plant resistance
Insect ecology- Insect abundance and diversity
Insect outbreak and climate change,
Insect plant interactions- allelochemicals-
Host selection process, Mechanisms of resistance, types of resistance,
Resistance breeding and biotypes

Unit IV Pest management
Threshold levels, biotic balance and principles of pest management
Cultural, mechanical, physical, chemical, host plant resistance, semiochemicals, entomophaga and entomopathogens, Sterilization and genetic control, Legal and quarantine measures, Surveillance and sampling

Unit V Insect biochemistry and molecular biology
Physiology of digestion, respiration, growth, development and reproduction
Neurobiology, Electrophysiology and volatiles
Haemocytes, neuroendocrine and neuropeptides in insects
Bacillus thuringiensis, Proteianse inhibitors, recombinant DNA technology, transgenics

References

1) David, B.V. and Kumarasamy, T. 1984. *Elements of Economic Entomology*, Popular Book Depot, Madras, 536 pp.
2) Nayar, K.K., Ananthakriahnan, T.N. and David, B.V. 1991. *General and Applied Entomology*, Tata McGraw-Hill publishing company, New Delhi, 590p.

3) Imms, A.D. and Richards, O W. 1994. *Imm's General Textbook of Entomology: Vol 1 Structure, physiology and development Vol2 Classification and biology*. Chapman and Hall, 1281 p.
4) Nair, M.R.G.K. 1989. *A Monograph on crops pests of Kerala and their control*, Kerala Agricultural University, 189 p.
5) Panda, N., and Khush, G.S.1995. *Host Plant Resistance to Insects*, CAB International, Wallingford, UK 431 p.
6) Srivastava, R.P. and Saxena, R.C. 1989. *A textbook of insect toxicology*, Himanshu publications, Udaipur, 166p.
7) Pedigo, L.P. 1999. *Entomology and pest management*, Prentice-Hall, Englewood Cliffs, NJ. 691 pp.
8) Srivastava, K.P. 1993 *Textbook of Applied Entomology* Vol I and II, Kalyani publications, New Delhi, 424 p.
9) Ananthakrishnan TN. 2007. *Dimensions of Molecular Entomology*, University press (India) Private Ltd., 162 p.
10) Ishaaya, I and Degheele, D. 1998. *Insecticides with novel mode of action*. Narosa Publishing house, New Delhi, 289 p.
11) Blum, M.S. 1985. *Fundamentals of Insect Physiology*, John Wiley and Sons, New York 598 p.
12) Romoser, W.S. 1981. *The Science of Entomology*, Macmillan Publishing Co., New York, 575 p.

Institute: CPCRI, Kayagulam
Kerala.

APPLIED ZOOLOGY
PH.D. COURSE WORK

PAPER III : RECENT DEVELOPMENTS

Fish Breeding and Hatchery Management

12 hours/ Unit **Total : 60 hrs.**

Unit I – Fish seed resources, natural breeding, riverine fish spawn collection, maturity, breeding season and development of gonads.

Freshwater and marine fish seed resources, Natural breeding of finfishes, Selection of riverine fish spawn collection sites, gear used and methods of collection, fish spawn quantity and quality indices, Sexual maturity , development of gonads, spermatogenesis, oogenesis.

Unit II – Breeding of carps

Breeding of carps in bundhs, induced breeding of warm water finifishes and environmental factors affecting spawing, Fish pituitary gland and synthetic hormones for incuced breeding of fishes, Fish brood stock management and transportation of broodfish, Induced breeding of Indian major carps and exotic carps (silver carp and grass carp), Major carp egg and embryonic developmental stages, Causes of mortality of fish eggs and spawn and their treatment.

Unit III – Fish hatcheries and fish seed rearing techniques

Importance of fish hatcheries, Traditional double – walled hapa, Chinese type of carp hatchety, Glass jar hatchery, Other hatchery devices, Hatchery water quality parameters, Importance of fish nursery, Spawn rearing techniques – nursery pond, Spawn rearing techniques – rearing pond, Packing and transportation of fish seed, Use of anaesthetics and disinfectants in fish seed and brood – stock transportation.

Unit IV – Breeding of other commercially important fishes

Breeding of common carp, Breeding of mahseers, Breeding of trouts, Breeding of tilapia, Breeding of catfishes, Breeding of grey – mullets, Breeding of milkfish, Breeding of Asian seabass, Breeding of groupers, Breeding of indigenous fishes.

Unit IV – Fish Genetics and breeding

Inbreeding in Indian major carps, consequences of inbreeding, inbreeding depression, genetic drift, Selective breeding – history, methods, mating design, planning of Selective breeding programmes, Cross breeding – types, uses, planning, Cryopreservation of fish gametes.

References:

1. Ayyappan, S; Jena, J.K; Gopalakrishnan and Pandey, A.K; 2006. Handbook of Fisheries and Aquaculture. ICAR, New Delhi.p.755.
2. Keshavanath, P. and Radhakrishnan, K.V; 1988. Proc. Carp seed production technology, Asian Fisheries Society, Indian Branch, Mangalore.p.94.

3. Nandeesha, M.C; 1990/1991. Breeding of carps with ovaprim in India. Asian Fisheries Society, Indian Branch, Mangalore.
4. V.R.P. Sinha and H.C. Srivastava. Aquaculture Productivity. Oxford and IBH Publlishing Co; New Delhi. P. 868.
5. Chaudhuri, H. and S. B. Singh. Induced breeding of carps. Indian Council of Agricultural Research, New Delhi. P. 82.
6. Pillay, T.V.R. Aquaculture – Principles and Practices, Long Garden Walk.p.575.
7. Chondar, S.L. Hypophysation of Indian major carps. Satish Book Enterprises. P.146.
8. Harvey, B.J. and J. Carolsfeld, 1993. Induced breeding in tropical fish culture. IDRC, Canada.
9. Harvey, B.J. and Hora, W.S. 1989. Theory and practice of induced breeding in fish. IDRC, Canada.
10. Jhingran, V.G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. 666p.
11. Transportation of live finfish and shellfish. CMFRI Special Bulletin No.66.
12. Assessment of freshwater fish seed resources for sustainable aquaculture. FAO Fish. Tech. Pap. No.501.
13. Tave, D; Genetics for fish hatchery managers,
14. Padhi, B.K. and Mandal, R.K. Applied fish genetics

Institute : Fisheries college, Mangalore , Veterinary University

APPLIED ZOOLOGY
PH.D. COURSE WORK

PAPER III : RECENT DEVELOPMENTS

Applied Fisheries Biology

12 Hrs/Unit **Total : 60 hrs**

Unit I – Biodiversity assessment

Biodiversity principles, categorization of species into endangered, threatened, extinct etc. methods, scales and indices of biodiversity assessment. Biodiversity of Gangetic river system, Cauvery river system, Himalayan lakes and rivers, west coast of India. Threat to biodiversity: over exploitation, case studies of marine and estuarine fisheries of India. Legal regimes and biodiversity. Introdiction of exotic species and their implication.

Unit II – Food and feeding habits

Food and feeding habits of commercially important finifishes and shellfishes. Food of fishes and its relationship to the morphological and anatomical features of digestive system. Quanlitative and Quantittative estimation of gut contents. Feeding intensity in relation to season and maturity cycle. Indices used in estimation of food. Factors affecting digestion rates; digestive enzyme activity and bioenergetics of fish.

Unit III - Conservation and Management of exploited fisheries Resources

Factors responsible for fishery productivity, marine parks, marine protected areas, biosphere reserves, closed seasons, mangrove afforestation, cryopreservation of exploited and endangered species. Implementation of square cod end mesh to reduce by catch. Management of major reservoirs, optiomal stocking and enhancement. FAO's code of conduct for responsible fisheries. Issues and challenges of multigear fisheries.

Unit IV - Fisheries Environmental Assessment

Critically important climatic factors (temperature, rainfall and wind pattern/ monsoon) influencing aquatic productivity and production. Remotely sensed SS, chlorophyll and wind pattern features of Indian seas. Potential Fishing Zones (PFZs). Influence of rainfall intensity, its seasonal and annual variations on fish migration, breeding, recruitment and production. Optimum water quality parameters prescribed for various water bodies (marine and inland) for different uses groups. Structure and trophic profile of marine, estuarine, reservoir and riverine ecosystem in relation to nutrient profile, plankton profile and oxygen profile.

Unit V – Applications of fisheries models in stock assessment

Development of fnalytical models, Logistic models of Schaefer and Fox, application of Beverton and Holt's model. Predator – prey models , stock recruitment models, Bio-economic models. Use of latest computer programmes to assess fish stocks such as FiSAT, yield isopleth's diagrams etc.

References

1. Bal, D.V. and K.V. Rao, 1990. Marine fishes of India (1st revised edn.), Tata MvGraw Hill Publishing Company Ltd., New Delhi, 472p.

2. FAO Fisheries Technical Papers on marine fisheries.
3. Kurian, C.V. and V.O. Sebastian , 1986. Prawns and prawn fisheries of India. Hindustan Publishing Corporation. New Delhi. P. 298.
4. Shanbhogue, S.L.2000, Marine Fisheries of India.. ICAR, New Delhi. 103 p.
5. R.J.H. Beverton and S.J.Holt. On the dynamics of exploited fish population. Pb. Chapman and Hall, London.
6. Gulland, J.A. 1977. fish population dynamics. John wiley and sons. Chichester. P. 422.
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8. Patel, A.N. and Surendra Singh. 1992. Remote sensing – Principal and Applications. Scientific publishers, Jodhpur.161 p.
9. FAO Fisheries Technical paper . No. 318. FAO, Rome. 162 p.
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Institute : Fisheries college, Mangalore , Veterinary University

APPLIED ZOOLOGY
PH.D. COURSE WORK

Paper III : RECENT DEVELOPMENTS

Agricultural Entomology

12 hrs / Unit Total : 60 hrs.

Unit I - Insects of agricultural importance:
Insect pests of annual crops, perennial crops;
Insect pests of stored products;
Insect vectors in relation to plant diseases.

Unit II -Productive Insects
Honey bees, silkworm – mulberry, eri, muga and tassar,
Lac insects and other productive insects,

Unit III - Methods and principles of pest control
Biological control of pests using predators, parasitoids and pathogens
Biological control of weeds,
Integrated Pest Management
Management of insect pests – using insecticides/biopesticides etc.

Unit IV - Insecticides
Classification of insecticides,
Plant protection appliances
Safety precautions.

Unit V – Insect pests of cashew
Tea mosquito bug and its management
Cashew Stem and root borers and its management
Minor pests of cashew and their management

References :

a) Vasantharaj David, B and Kumar Swamy, T. Elements of Economic Entomology. Popular Book Depot. Chennai.
b) Justin, C.G. Edward, Y.S.J.I. A compendium of Entomology. Butterfly Publications, Coimbatore.
c) Nair, M.R.G.K. Insect and mites of crops in India. Publications and Information Division, Indian Council of Agricultural Research, New Delhi
d) Shivarama Bhat, P and Raviprasad. T.N. Tea mosquito bug and its management in cashew. DCR Technical Bulletin No. 19, Directorate of Cashew Research, Puttur, Karnataka.
e) Raviprasad. T.N. and Shivarama Bhat, P. Cashew stem and root borer – A major pest of cashew, DCR Technical Bulletin No. 11, Directorate of Cashew Research, Puttur, Karnataka.

Institute : Cashew Research Station, Puttur, Karnataka.

APPLIED ZOOLOGY
PH.D. COURSE WORK

Paper III: RECENT DEVELOPMENTS
Aquatic Animal Health

12 hours/Unit **Total: 60 hours**

Unit I- **FISH AND SHELLFISH VIROLOGY**

Molecular virology and pathogensis of selected viruses infecting fish and shellfish
Recent research advances in antiviral drugs, viral vaccines
Eemerging viruses and evolution of new viruses.

Unit II- **ADVANCES IN PARASITOLOGY**

Environmental parasitology
Host-parasite interaction: Pathological changes induced in host due to parasitic infection
Molecular parasitology
Evolution of parasites; Hyperparasitism
Antiparasitic drugs applied in aquaculture and their action
Parasitic immunity; Immune evasion strategies of parasites

Unit III- **ADVANCES IN IMMUNOLOGY**

Cellular Interactions in the Immune System
Regulation of the Classical Pathway of Complement; Regulation of the Alternative Pathway of Complement
Molecular immunology; pathogen recognition receptors
Crustacean immunology

Unit IV- **BIOTECHNOLOGICAL TOOLS IN DISEASE DIAGNOSIS**

Advances in disease diagnostic procedures in aquaculture
Antibody-based diagnostics
Molecular diagnostic methods such as *in situ* hybridization nucleic acid probe-based diagnosis
Various types of polymerase chain reaction (PCR) such as conventional one step, nested and semi-nested PCR, RT-PCR, real-time PCR; LAMP etc.

Unit V- **CRUSTACEAN PATHOLOGY**

Normal histology of different organs of crustaceans with special reference to penaeid shrimp
Major pathogens of commercially important cultured crustaceans with special reference to shrimp and freshwater prawn pathogens: viral, bacterial, fungal and parasites

Suggested Readings

1. Roberts RJ. 2001. *Fish Pathology*. 3nd Ed. W.B. Saunders.
2. S.J. Flint, LW Enquist, RM Krug, VR Racaniello, AM Skalka. 2000. Principles of Virology. Molecular Biology, Pathogenesis and Control.

3. Alan Cann. 2005. Molecular Virology. Academic Press 315 p.
4. Dimmock N Easton A and Leppard K. 2006 Introduction to Modern Virology. Sixth edn Blackwell publishing. 536 p.
5. David M. Knipe, PhD; Peter M. Howley, MD; Diane E. Griffin, MD, PhD; Robert A. Lamb, PhD, ScD; Malcolm A. Martin, MD; Bernard Roizman, ScD; Stephen E. Straus, MD 2007. Fields Virology. 5th edn. Lippincott Williams & Wilkins. 3177p.
6. Freshney I R. 1994. Culture of Animal Cells: A Manual of Basic Technique 3rd edition. Wiley-Liss, Inc. New York. 486 p.
7. Mothersill C and Austin B. 2000. Aquatic Invertebrate Cell Culture. Springer –Praxis, Chichester UK. 405 p.
8. Lewis EE, Campbell JF &Sukhdeo MVK. 2002. *The Behavioural Ecology of Parasites*. CABI.
9. Poulin R & Grimes LR. 2007. *Evolutionary Ecology of Parasites*. Princeton University Press.
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19. Sambrook J & Russel D. 2001. *Molecular Cloning*. 3rd Ed. Cold Spring Harbour Laboratory.
20. Philippa D.Davbre. Basic Molecular Biology: Essential Technique. John Wiley and Sons, New York. P194

Institute: Central Institute of Fishery Education, Muba

APPLIED ZOOLOGY
PH.D. COURSE WORK

Paper III: RECENT DEVELOPMENTS

Genetics and Breeding

12 hrs/unit **Total - 60 hours**

Unit I:
Physical basis of heredity; probability concepts; Mendelian principles: scope and limitation; Interactions and Epistatsis; Chromosome theory of inheritance: genetic basis of sex determination.
Unit II:
Cell structure; Organization and function of sub-cellular organelles; Cell division: Cell division: Cell cycle and its regulation; Cytogenetics: Cytogenetics and evolution; Karyotyping; Linkage and crossing over; Mutation; Nucleic Acids: Genetic material - Structures of DNA and RNA.
Unit III:
Modern concept of gene; DNA as genetic material; Extrachromosomal DNA: Mitochondria, chloroplast, plasmids (circular and linear), organization and replication; DNA Repair: Types and mechanisms; Recombinant DNA technology.
Unit IV:
Historical development of fish breeding and domestication; Current status of aquaculture and Fisheries in world and India; Application of genetics for conservation; Conservation and preservation of aquatic species: Issues and strategies; Gamete quality analysis and preservation.
Unit V:
Application of genetic principles to population; Evolution and Genetic conservation strategies; Genetic evaluation and genetic improvement programs; DNA bar-coding and molecular identification of species; Introduction to various national and international programs on bar codes.

Institute: Central Institute of Fishery Education, Mubai

APPLIED ZOOLOGY
PH.D. COURSE WORK

Paper III: RECENT DEVELOPMENTS

Biochemistry and Nutrition

12 hrs/unit **Total - 60 hours**

Unit I- Carbohydrates and lipids
Metabolism of carbohydrates; Glycolysis, Glycogen metabolism and TCA cycle, pentose phosphate pathway.
Utililzation, transport and storage of lipids
Cholesterol, lipoproteins and cardiovascular diseases.
Role of EPA, DHA in health and diseases.

Unit II- Proteins
Transport proteins, hormonal proteins and their functions
Protein evolution, haemoglobin and myoglobin, haemoglobin variants, oxygen transport.
Protein folding, molecular chaperons, stress proteins and adaptation mechanisms.
Enzymes: Kinetics, inhibition and regulation of enzyme catalyzed reactions.
Immunoglobins: structure of antibodies, generation of diversity and immune responses.

Unit III - Introduction to nutrition
Classification of feeds.
Common methods of analysis of nutrients and feed stuffs.
Morphology and fine structure of vertebrate digestive system.
Physiology of digestion, absorption and their regulation.

Unit IV – Nutrition and diseases
Functional significance of nutrition
Nutritional deficiency disorders
Nutrition and degenerative diseases
Food toxicants; dietary antioxidants.

Unit V – Applied Nutrition and Biochemistry
Nutraceuticals for growth and immunity
Nutrigenomics and their applications
Nutrient delivery through nano particles
Electron radiation for enhancement of shelf life and nutritional quality of feed ingredients
Feed formulation and quality evaluations.

References:
1. Devlin, T.M. 1993. Text book of biochemistry with clinical Correlations, Wiley Liss, Inc; Newyork.
2. Emil Smith et, AI;(1983) Principles of biochemistry: General Aspects (7th Edition) Acukland,
Mcgraw Hill bokk, Kogakusha.
3. Lehninger A.L. (1997) Biochemistry current edn. W.H.Freeman and Co;SanFransisco.

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8. Goldsly R.A; Kindt T.I. Osborne B.A and Kuly J. (2003) Immunology fifth edn. W.h. Fruman and Co; New York.
9. Mathews C.K. Holdevan K.E and Ahren K.G (2005) Biochemistry Peanon Education, New Delhi.
10. Voet D. and Voet J.D. (1995) Biochemistry IIndEdn. John Wiley and Sons INC., New York.

Research Institute: Central Institute of Fisheries Education
Deemed University, Mumbai

APPLIED ZOOLOGY
PH.D. COURSE WORK

Paper III: RECENT DEVELOPMENTS

Biodiversity and Conservation

12 hrs/unit **Total - 60 hours**

Unit I – Introduction
Definition and types of biodiversity, recent trend in aquatic biodiversity with reference to different phyla, factors affecting biodiversity, climate change and biodiversity, methods for assessment and conservation of aquatic biodiversity.

Unit II- Taxonomy
Introduction, importance and principles of taxonomy, preparation of identification key for important groups of aquatic organisms: vertebrates – fishes, invertebrates – crustaceans, mollusks etc. traditional and truss morphometry, recent advances in taxonomy molecular taxonomy.

Unit III- Plankton
Significance of plankton study, classification, factors affecting production, occurrence, distribution and density, methods of collection and study, estimation of primary and secondary production of an aquatic ecosystem.

Unit IV- Fishery biology
Status of fish production in India, reasons for decline of fish catch, overexploitation Stock enhancement, feeding and reproductive biology of fishes, sustainable management of aquatic resources, co-management, and ecosystem based management.

APPLIED ZOOLOGY
Ph.D. Course Work

Paper III : Recent Developments
Radiation Biology

12 hours/unit **Total: 60 hours**

Unit 1: Basic Radiation Physics
Atomic and nuclear structure – Rutherford's and Bohr's atomic models, nucleus and its constituents, isotopes, isobars and isomers. Electromagnetic radiation – Ionising and non-ionising radiations. Radioactivity – Radioactive decay, decay constant, half-life, biological half-life, types of ionising radiations (alpha, beta, X-ray and gamma radiations) and radioisotopes. Radiation sources – Natural and artificial radioactive sources.

Unit 2: Radiation Measurements, Quantities, Units and Protection
Basic principles of radiation detection - GM detectors, scintillation detectors, semiconductor detectors, solid state nuclear track detectors (SSNTD) and thermo luminescent dosimeters (TLD). Radiation quantities and units – Activity, radiation exposure, absorbed dose, equivalent dose and effective dose. Linear energy transfer (LET). Radiation protection **-** Objectives of radiation protection, committees and regulatory bodies concerned with risk estimates and radiation protection, occupational and non-occupational exposure.

Unit 3: Interaction of Radiation with Cells
Action of radiation on living cells - Radiolytic products of water and their interaction with biomolecule - Nucleic acids, proteins, enzymes, fats - Influence of oxygen, temperature - Cellular effects of radiation - Mitotic delay, chromosome aberrations, mutations and recombinations - Giant cell formation, cell death Recovery from radiation damage - Potentially lethal damage and sublethal damage recovery.

Unit 4: Biological Effects of Radiation
Somatic effects of radiation - Physical factors influencing somatic effects - Dependence on dose, dose rate, type and energy of radiation, temperature, anoxia, - Acute radiation sickness - LD 50 dose - Effect of radiation on skin and blood forming organs, digestive tract - Sterility and cataract formation - Effects of chronic exposure to radiation - Induction of leukaemia - Radiation Carcinogenesis - Risk of carcinogenesis - Animal and human data - Shortening of life span - In-utero exposure - Genetic effects of radiation - Factors affecting frequency of radiation induced mutations - Dose-effect relationship - first generation effects.

Unit 5: Biological Applications of Radiation and Radioisotopes
Diagnostic techniques, radiotracers techniques for diagnosis and treatment, cancer therapy, autoradiography techniques, gamma knife radiosurgery, *Helicobacter pylori* infection diagnosis by Carbon-14 urea breath test, radioimmunoassay (RIA) and immunoradiometric assay (IRMA).

References:

Books

1. Choppin, G.R., Rydberg J., Lilijenzin J and Ekberg C. (2013) Radiochemistry and nuclear chemistry. Elsevier.

2. L' Annunziata MF (2007) Radioactivity: Introduction and History. Elsevier.

3. Lowenthal, G.C and Airey, P.L (2004) Practical application of radioactivity and nuclear radiations. Cambridge University Press, UK.

4. Mann, W.B., Rytz A and Spernol A (1991) Radioactivity measurements: Principle and practise. Pergamon Press.

5. Woods, R.J and Pikaev A.K (1994) Applied Radiation Chemistry: Radiation Processing. Wiley Inter-science Publication, USA.

6. Yarmonenko, S.P. (1988) Radiobiology of humans and animals. Mir Publishers, Moscow.

Journals

1. Indian Journal of Nuclear Medicine, Published by Medknow

2. Radiation Protection and Environment. Publication of Indian Association for radiation protection (IARP), ISSN-0972-0464

3. Applied Radiation and Isotopes. Elsevier. ISSN: 0969-8043

4. International journal of radiation biology. Informa Helathcare. ISSN: 0955-3002

APPLIED ZOOLOGY
Ph.D. Course Work

Paper III : Recent Developments
Fishery Biology and Aquaculture Management

12 hours/unit **Total: 60 hours**

Unit-I - Biodiversity assessment and conservation of the fish resource:

Biodiversity principles, Indices of biodiversity assessment of fish species. Diversity of fresh water, marine and estuarine fishes of India. Threats to biodiversity- overexploitation, exotics, pollution and case studies of fresh, marine and estuarine fisheries of India. Factors influencing fishery productivity. Marine parks, marine and freshwater protected areas. Fishing closed seasons, mangrove aforestation, cryopreservation of exploited and endangered species. Plankton diversity, Sustainable management of aquatic ecosystem, Implementation of square cod end mesh to reduce by catch. Management of major reservoirs, optimal stocking and enhancement. FAO's code of conduct of responsible fisheries. Issues and challenges of multigear fisheries. DNA bar coding and their utilization in conservation of fish biodiversity and biotechnology applications in fish and shellfish conservation

Unit-II- Biology of fishes and fisheries environmental assessment:

Length-weight relationship, Growth, age determination, food and feeding habits of commercially important fin fish and shellfishes. Qualitative and quantitative estimation of gut contents. Fish spawning, reproductive cycles, Principles of fish genetics and breeding, methods of breeding, sex determination. Critically important climatic influences on aquatic productivity. Potential Fishing Zones (PFZs). Optimum water quality parameters prescribed for various bodies (marine and inland) for different uses groups. Structure and trophic profile of marine, estuarine, reservoir and revirine ecosystem in relation to nutrient profile, plankton profile and oxygen profile.Application of various fisheries models in stock assessment- Beaverton Holt's Model, Logistic model of Schaefer and Fox, predator –prey models, Stock recruitment models, Bioeconomic models. FiSAT, yield isopleth's diagram etc

UNIT-III- Aquaculture management:

Fish culture- freshwater and lacustrine culture practices in India. Ornamental fish culture, Brackish water aquaculture, Mariculture- finfish and shellfish culture. Seed production of cultivable fishes, crustacean and molluscs. Advances in aquaculture production systems, seed production and hatchery management. Aquaculture feed technology- Larval nutrition and culture of fish food organisms, Aquaculture engineering, Fish and shellfish physiology and endocrinology, Aquaculture and environment. Importance of fish hatcheries and fish rearing techniques. Fish nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and nutritional bioenergetics- adults; role of natural food in fish nutrition. Feed performance and economics. Transgenic fish, detection of transgenic, applications, regulatory aspects of transgenesis.

UNIT-IV- Aquatic animal health management:

Basics of fish and shellfish health management: Host-pathogen-environment relationship. Diseases in aquaculture- parasitic, bacterial, viral and fungal pathogens of fish and shellfish. Water, soil, environmental parameters and their effects on fish health. Disease in hatcheries and grow out systems. Epidemiology of Diseases, nutritional pathology, Techniques in health management: Microbiological, hematological, histopathological, immunological and molecular techniques. Disease surveillance and reporting. Defence system in fish and shellfish: Innate and acquired immunity, inflammation response to diseases. Methods for disease control and management- Environment management, chemotherapeutic agents, host management, prophylaxis- vaccines, adjuvants, immunostimulants and probiotics.. Fish health and quarantine systems. Seed certification, SPF and SPR. Biotechnology in health management: molecular nucleic acid and antibody based diagnostics, vaccines.

UNIT-V- Fisheries economics and marketing:

Nature and scope of natural resource economics, bioeconomic analysis of fisheries. Fisheries resource management policies- taxes, subsidies, permits and direct controls. Nature and scope of aquaculture economics. Theories of Factors of Production. Factor - Product Relationship, Factor - Factor Relationship, Product- Product Relationship Costs and Income Concepts in Fisheries, Resource Use Efficiency Analysis, Risks and Uncertainties in Fisheries Price Analysis , The Price Index Number, Market and Marketing Structure, Government and Co-operative in Marketing , Market Equilibrium and Market Structures Cobb-Douglas quadratic production functions, Economics of intensive and semi intensive aquaculture; Role of marketing in fisheries and aquaculture. The Fish Processing Industry and the Fish Trades. Strategies and Methods for Promoting Fisheries Development.

References:

1. Ackefors H. (1994), Introduction to the General Principles of Aquaculture,Taylor & Francis,172, Pages.

2. Ayyappan.S; Jena, J.K; Gopalkrishanan and Pandey, A.K;2006. *Hand book of fisheries and Aquaculture*.ICAR, New Delhi.P.755.

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12. Felix, S. Riji John, K, Prince Jeyaseelan, M.J. and Sundararaj V. (2001). *Fish Disease Diagnosis and Health Managemen*t. Publication by Fisheries College and Research, Institute, T.N. Veterinary and Animal Sciences University.

13. Gulland, J.A., (1983). *Fish Stock Assessment; A manual of Basic Methods*, John Wiley &Sons,Singapore.

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15. Guillame, J., Kaushik, S., Berqot P., and Metallier, R., (2001). *Nutrition and feeding of fish and crustaceans*, Springer Praxis Publishing, Chichester, UK.

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