

GONDWANA UNIVERSITY GADCHIROLI
SEMESTER SYSTEM SYLLABUS
FOR
M.Sc. Part II
Subject- Zoology, Semester-IV,
Paper XIII- Biotechniques, Biostatistics and Ethology

Unit-I

- 1.1 Sterilization techniques, media for microbial culture, inoculation methods.
- 1.2 Animal cell & tissue culture- primary culture, cell lines, cell quantification, growth kinetics of cells in culture, cryopreservation of cells.
- 1.3 *In vitro* fertilization technology, cloning, socio-ethical issues of cloning.
- 1.4 Cell separation by Flowcytometry.

Unit-II

- 2.1 Basic principle of sedimentation, Preparative centrifugation, analytical centrifugation and applications of ultracentrifugation in cell fractionation.
- 2.2 Radioactive isotopes, half lives of radioisotopes, isotope techniques in biology and autoradiography.
- 2.3 Chromatographic separation: Thin layer and gas chromatography, High performance liquid chromatography (HPLC).
- 2.4 Electrophoretic separation techniques.

Unit-III

- 3.1 Introduction to statistics and Biostatistics- history, subdivision of statistics, data type, steps in statistical methods, Graphical representations of data in tabular form, characteristic and classification of table, line chart, histogram, bar diagram, pie diagram, cumulative frequency tables and diagrams.
- 3.2 Central tendency and dispersion-Descriptive statistics, central tendency, mean, median and mode with examples, dispersion, and variance.
- 3.3 Probability and probability distribution -Basic theory and type of probability and probability distribution with example (binomial, poisson and normal distribution).
- 3.4 Sampling – types, standard error (SE), standard deviation (SD), significance tests – t test, z-test, Chi square test- assumption, importance and example.

Unit-IV

- 4.1 Population ecology- population structure, distribution, growth, density, fluctuation and dispersal.
- 4.2 Orientation, navigation and homing.
- 4.3 Neuronal control, genetic and environmental components in development of animal behaviour.
- 4.4 Animal ethics- Introduction, concept, organizations and their functions.

M.Sc.II Semester-IV
Paper-XIV, Toxicology and Bioinformatics

Unit-I

- 1.1 Introduction and Scope of Toxicology
- 1.2 Principles of Testing for Toxic Effects
- 1.3 Absorption, Distribution, Metabolism and Excretion of Toxicants
- 1.4 Mechanisms of Toxicity-receptor concept, nature of receptors, theory of toxicant receptor interaction and mechanism of action.

Unit-II

- 2.1 Environmental toxicants-Pesticides, Fertilizers, Heavy and trace metals, radioactive substances, food additives, Automobile emission, their accumulation, residual effects distribution in body and excretion
- 2.2 Toxicants at organ and system level- Tetratogens- causes, mode of action and evaluation.
- 2.3 Nutritional toxicology- Potential toxicants in foodstuff, natural toxic compound, Industrial contaminants, food additives, liver function test in toxicology and Antidotal procedure (type of intoxication, administration of antidotes and chelation theory)
- 2.4 Physiological and Biochemical Impact of toxicants on aquatic organisms.

Unit-III

- 3.1 Scope of bioinformatics - history, scope of bioinformatics in research, business and employment opportunities.
- 3.2 Bioinformatics and internet.
- 3.3 Human genome project and online Mendelian inheritance in man (OMIM).
- 3.4 Bioinformatics in India- current status and future implication.
- 3.5 Databases - content, structure and annotation and type of databases.

Unit-IV

- 4.1 Biological databases retrieval tools and systems – sequence similarity searches, FASTA, BLAST, interactive databases searches and PSI-BLAST.
- 4.2 Multiple sequence alignment and family relationships.
- 4.3 Protein domain family and protein databases.
- 4.4 Phylogenetics analysis- tree styles, tree building method, evolution of macromolecular sequence tools for making and drawing trees (phylip and clustlw).

Suggested Readings

Tissue culture and Biotechniques

1. Animal cell culture – A practical approach, (III Edition) Ed. John R. W. Masters. IRL Press.
2. *In vitro*-cultivation of animal cell, biotechnology by open learning (BIOTOL), Butterworth Heinemann Ltd. Linaere house, Jordan Hill Oxford.
3. Introduction to instrumental analysis, Robert Broun, McGraw Hill International Edition.
4. A Biologist Guide to Principle and Techniques of Practical Biochemistry K. Wilson and K.H. Goulding ELBS Edition.
5. Molecular Cell Biology, J. Darnel, H. Lodish and D. Baltimore. W. H. Freeman and Company New York.
6. DNA Techniques by Alcamo.
7. Insect Cell Culturing Engineering, Ed. M. F. A. Goosen, A.J. Daugulis and P.Faulkner.
8. Biotechnlogy - B. D. Sings.
9. Biophysical Chemistry – Upadhyay, Upadhyay and Nath.

Toxicology

1. Animal Clinical Chemistry: A Primer for Toxicologists. G.O. Evans (Ed.) ISBN: 0748403515, Taylor & Francis, 1996.
2. Animal Models in Toxicology. S.C. Gad & C.P. Chengelis (Eds.), ISBN: 0824784561, Marcel Deker, 1992.
3. Annual Reviews of Pharmacology & Toxicology, ISBN: 0824304373, 1997
4. Basic Toxicology: Fundamentals, Target Organ & Risk Assessment. F.C. Lu, ISBN: 1560323809, Taylor & Francis, 1996.
5. Casarett & Doull's Toxicology: The Basic Science of Poisons. C.D. Klaassen (Ed), ISBN: 0071054766, McGraw-Hill, 1996.
6. Comprehensive Toxicology. I. Sipes, C.A. McQueen & A. Gandolfi (Eds.), ISBN: 0080423019, Elsevier Science, 1997.
7. General & Applied Toxicology. B. Ballantyne, T. Mars & P. Turner (Eds), Vol I & II, ISBN: 0333498011, Macmillon/Stockton Press, 1993.
8. Loomi's Essentials of Toxicology, T.A. Loomis & A.W. Hayes, ISBN: 0124556256, Academic Pess, 1996.
9. Encyclopaedia of Toxicology, Chemical and Concepts, P. Wexler, ISBN: 012227220- X, Academic Press, 1998.
10. Dictionary of Toxicology. E. Hogson, J.E. Chambers & R.B. Mailman, ISBN: 1561592161, Groves ic, 1997.

Biostatistics

1. Biostatistics-Arora and Malhan
2. Biostatistics- Jasraj and Gurudeep Raj
3. Biostatistics- P. Ramkrishan
4. Methods in Biostatistics-Mahajan

Bioinformatics

1. Mount W. 2004. Bioinformatics and sequence genome analysis 2nd Editon CBS Pub. New Delhi.
2. Bergman, N. H. Comparative Genomics. Humana Press Inc. Part of Springer Science+BusinessMedia, 2007.
3. Baxevanis, A. D. Ouellate, B. F. F. 2009. Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
4. Campbell A. M. and Heyer, L. J. 2007. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings.
5. Des Higgins and Willie Taylor 2000. Bioinformatics: Sequence, structure and databanks. Oxford University Press.

6. Rashidi H. H. and Buehler 2002. Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.
7. Gibas Cynthia and Jambeck P. 2001. Developing Bioinformatics Computer Skills: Shroff Publishers and Distributors Pvt. Ltd. (O'Reilly), Mumbai.

Semester-IV
Paper-XV, Special Group-Entomology-III
Sense organs, social life and Agriculture pests

Unit-I

- 1.1 Compound eyes- structure and functions.
- 1.2 Ocelli- structure and functions.
- 1.3 Sound producing organs: Structure and physiology.
- 1.4 Light producing organs: Structure and bioluminescent mechanism.

Unit-II

- 2.1 Mechanoreceptors: Sensory hairs, campaniform sensilla and chordotonal organs.
- 2.2 Tympanal organs, Johanson's organ, Chemoreceptors- sensilla trichoidea, sensilla basiconica.
- 2.3 Pigments and mechanism of colour change, mimicry and camouflage.
- 2.4 Immunity in insect: Innate immunity and molecular mechanism.

Unit-III

- 3.1 Social life: Polymorphism, nest building and social behavior in Isoptera.
- 3.2 Social life: Polymorphism, nest building and social behavior in ants.
- 3.3 Parasitic Hymenoptera-types and significance.
- 3.4 Locust migration and swarming.

Unit-IV

- 4.1 Pest of major crops: Rice, Cotton and Sugarcane-classification, life history, damage and control.
- 4.2 Pest of fruits: Citrus and Mango-classification, life history, damage and control.
- 4.3 Pest of vegetables: Cabbage and Brinjal- classification, life history, damage and control.
- 4.4 Stored grain pests: classification, life history, damage and control measures.

Semester -IV

Paper-XV, Special Group-Fish and Fisheries-III

General studies

Unit-I

- 1.1 Structure of alimentary canal in teleosts; feeding habits, histology of different parts
- 1.2 Modification of alimentary canal in relation to feeding habits, digestion and absorption of food.
- 1.3 Structure of kidney in teleosts: Head kidney and trunk kidney, histology, blood supply
- 1.4 Osmoregulation in Freshwater forms, Marine forms, Rays and Skates, Diadromous fishes.

Unit-II

2.1 Chemoreceptors: Structure of olfactory system, morphology of peripheral olfactory organ, cellular composition of olfactory epithelium, olfactory bulb and central projections.

2.2 Structure and functions of taste buds.

2.3 Migration in fishes: Types- Anadromous, Catadromous, Amphidromous, factors responsible for migration (Intrinsic and environmental), periodicity of migration.

2.4 Role of hormones in migration, Orientation and Navigation during migration.

Unit-III

3.1 Structure of male reproductive system

3.2 Mechanism of spermatogenesis and its hormonal control

3.3 Structure of female reproductive system

3.4 Oogenesis, egg development, hormonal control of oogenesis

Unit-IV

4.1 Structure, hormones and functions of pituitary gland in fishes

4.2 Structure, hormones and functions of other endocrine glands.

4.3 Structure of Hypothalamo-hypophysial system in fishes.

4.4 Neurohormones and their functions.

Semester –IV

Paper-XV Special Group-Aquaculture- Aquaculture and Management

Unit-I

1.1 Preparation of pond: Liming and manuring.

1.2 Prestocking management of Nursery, Rearing and stocking ponds.

1.3 Control of aquatic weeds, predatory fishes, weed fishes and insects.

1.4 Post stocking management – stocking density, carrying capacity, enhancement of carrying capacity.

Unit-II

2.1 Nutritional requirements of culturable carps. Supplementary feeding. Artificial feed. Use of growth promoting hormones.

2.2 Transport of live fish seed, Brood fish and food fish.

2.3 Effect of dams on fisheries.

2.4 Development of reservoir fisheries in India.

Unit-III

3.1 Different systems of aquaculture, Monosex culture, cage culture and pen culture.

3.2 Polyculture of Indian and Exotic carps.

3.3 Culture of air breathing fishes.

3.4 Integrated aquaculture: fish-cum-poultry and fish-cum-paddy.

Unit-IV

4.1 Integrated fish farming: fish-cum-duck and fish-cum-pig

4.2 Sewage fed fish culture.

4.3 Cold water fish culture in India.

4.4 Extensive, Intensive, Semi-intensive and super- intensive culture.

Semester - IV
Paper-XV Special Group-Environmental Biology-III
Environmental Pollution and Aquaculture

Unit-I

- 1.1 Pollution Ecology: definition, sources of pollution, classification of pollutants, primary and secondary pollutants.
- 1.2 Air pollution: definition, sources, air pollutants and its effects on human health and atmosphere, control of air pollution.
- 1.3 Water Pollution: definition and sources, water pollutants and its effects, control of water pollution.
- 1.4 Noise pollution, sources, physiological and psychological effects of noise pollution, control measures of noise pollution.

Unit-II

- 2.1 Land pollution: definition, sources, effects and control of insecticide pollution.
- 2.2 Radioactive pollution: definition, sources, effects and control measures of radioactive pollution.
- 2.3 Biomedical waste: sources, effects and control measures
- 2.4 Hazardous waste: definition, sources, effects.

Unit-III

- 3.1 Biological and general effects of pollutants on organism.
- 3.2 Bioassay studies: definition, purpose, methodology, calculation of LC50 value, significance.
- 3.3 Bioaccumulation and biomagnifications.
- 3.4 Biotransformation of xenobiotics.

Unit-IV

- 4.1 Aquaculture: basic concept of fisheries, marine, inland and brackish water fisheries.
- 4.2 Indian major carps and their culture: fish, seed resources, transport.
- 4.3 Planning and management of freshwater fish farm.
- 4.4 Fishery economics and management: role of fishery co-operative societies, economics of fishery, aquaculture and rural development.

Semester-IV
Paper- Paper-XVI, Special Group-Entomology-IV
Pest control measures and Insects vectors

Unit-I

- 1.1 Inorganic insecticides: Properties, mode of action and use.
- 1.2 Chlorinated Hydrocarbons: Properties, mode of action and use.
- 1.3 Organophosphates: Properties, mode of action and use.
- 1.4. Natural organic compound and pyrethroids: Properties, mode of action and use.

Unit-II

- 2.1 Biological control: Historical and theoretical basis of biological control.
- 2.2 Desirable attributes of natural enemies of pests.
- 2.3 Parasitoids used in biological control programmes: life cycle and biological relationship.
- 2.4 Predators used in biological control programmes: life cycle and biological relationship.

Unit-III

- 3.1 Insect pathogenic bacteria used in biological control programmes, biological relationship, mass production and examples.
- 3.2 Insect pathogenic viruses used in biological control programmes, biological relationship, mass production and examples
- 3.3 Use of radiation, chemosterilants, hormones and pheromones in pest control programmes.
- 3.4 Integrated pest managements: principles, modeling, application and examples.

Unit-IV

- 4.1 Pest of horse and cattle: Nature of damage, life cycle and control measures.
- 4.2 Mosquitoes causing disease in man: Pathogens, diseases, mode of transmission and control.
- 4.3 Flies causing disease in man: Pathogens, diseases, mode of transmission and control.
- 4.4 Lice and fleas causing disease in man: Pathogens, diseases, mode of transmission and control.

Semester –IV
Paper-XV, Special Group-Fish and Fisheries -IV
Fishery technology and Fish pathology

Unit-I

- 1.1 Pond management (sitting construction and problems)
- 1.2 Gear and crafts in inland water
- 1.3 Conservation of fish, Fish legislation and their importance.
- 1.4 Water pollution and inland fisheries

Unit-II

- 2.1 Plankton in relation to fish production,
- 2.2 Culture of phytoplankton and zooplankton (Daphnia, Artemia, Monia)
- 2.3 Manufacture and maintenance of Aquarium
- 2.4 Hybridization and transgenic fish

Unit-III

- 3.1 Fish marketing: Marketing practices, information, marketing channels and systems
- 3.2 Domestic and export marketing.
- 3.3 Sex control and sex reversal under condition and chromosome set manipulation in fish
- 3.4 Gamete preservation: cryopreservation and its application.

Unit-IV

4.1 Methods of curing and preservation of fish. i. Refrigeration and freezing, ii. Drying, iii. Salting, iv. Smoking, v. Canning

4.2 Fish products and by-products: i. Fish body oil, ii. Fish liver oil, iii. Fish meal, iv. Isinglass, v. Fish protein concentrate, vi. Fish glue, vii. Fish manure

4.3 Fish pathology: i) Signs of sickness and effects on fish, ii) Pathological procedure for diagnosis of fish diseases

4.4 Fish diseases and its control: Biotic (fungal, bacterial and viral etc.) and Abiotic. a) Viral diseases, b) Bacterial diseases, c) Fungal diseases, d) Protozoan diseases

Semester-IV

Paper-XV, Special Group-Aquaculture-IV

Fish Pathology and Fish Genetics

Unit-I

- 1.1 Biochemical composition of raw fish.
- 1.2 Nutritional value of raw and preserved fish.
- 1.3 Fish preservation objective and principles..
- 1.4 Methods of fish preservation.

Unit-II

- 2.1 Fish decomposition, rigor mortis and fish spoilage.
- 2.2 Poisoning, Toxicity and allergies from fish as food.
- 2.3 Effect of water pollution on fishes.
- 2.4 Fish products and byproducts.

Unit-III

- 3.1 Fungal, bacterial, protozoan diseases of farm fish.
- 3.2 Nutritional diseases of fish.
- 3.3 Worm and crustacean diseases of farm fish.
- 3.4 Diseases caused by aquatic pollutants.

Unit-IV

- 4.1 Fish genetic resources and its application in fisheries management.
- 4.2 Hybridization, transgenic fish.
- 4.3 Gene banking and application of genetic engineering in aquaculture.
- 4.4 Cryopreservation of gametes.

SEMESTER IV

Paper-XV, Special Group-Environmental Biology IV

Man and Environment

Unit-I

- 1.1 Natural resources: definition, concept , types of natural resources, use and abuse of natural resources.
- 1.2 Wild life: wild life in India, endangered species of mammals, birds, amphibian and reptiles,
- 1.3 Causes of wild life depletion, necessity of wild life conservation.
- 1.4 Modes of conservation, national parks and sanctuaries, strategies for biodiversity conservation, gene pool.

Unit-II

2.1 National resources: minerals, nutrient cycles, exploitation of nutrient resources.

2.2 Biomass, biogas and solar energy.

2.3 Conservation and sustainable development of natural resources, bacteria and biodegradation

2.4 Biodiversity- definition, types, hotspots of biodiversity.

Unit-III

3.1 Conservation of natural resources: potable water criteria, water supply, water borne diseases and control measures, bioremediation of ponds and lakes.

3.2 Process of soil formation, composition, soil profile, soil erosion, methods of conservation of soil.

3.3 Conservation of forest: needs, afforestation, deforestation, agroforestry, forest conservation through law.

3.4 Social forestry and environment.

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Unit-IV

4.1 Environmental policy, social economic and legal aspects, social forestry, enforcement of anti pollution law.

4.2 Environmental education: environmental education programmes, environmental education in India

4.3 Formal environmental education, stages of environmental education, non formal environmental education.

4.4 Environmental Organizations and agencies.

Semester-IV, Practical-VII, Special Group-Entomology

1. Anatomical observations, demonstration and detailed explanation of the silk gland in mulberry and non mulberry silkworms with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

2. Anatomical observations, demonstration and detailed explanation of the male and female reproductive system in silk moths with the help of ICT tools/ models/ charts/ photographs etc.

3. Anatomical observations, demonstration and detailed explanation of the salivary, pharyngeal glands and sting apparatus in honey bees with the help of ICT tools/ models/ charts/ photographs etc.

4. Demonstration of disease causing pathogens in insects.

5. Histopathological Study of baculovirus and protozoan infected tissues with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

6. Collection of insect photographs, identification and classification of harmful insects, parasitic hymenopteran and other beneficial insects.

7. Listing of insects of different orders of central India.

8. Study of various systems of insects and their functional significance with the help of ICT tools/ charts/ models/ photographs etc.

9. Preparation of photographic life history of economical important insects.

10. Preparation of insect biodiversity register of a specific area by photographic collection/ observation.
11. Visit to Apiculture, Sericulture, Lac culture centers and entomology research laboratory/center

Distribution of Marks: Total Marks:80

1. Anatomical Observation	15
2. Identification, classification and economic importance of spots (1 to 10)	20
3. Demonstration of microbial pathogen in insect	10
4. Whole mount preparation	10
5. Class record and submission of slides	10
6. Submission of life history	10
7. Viva-voce	05

Total Marks	80
Internal Assessment	20

Total marks	100

Project work 100

(80 marks project evaluation including viva + 20 marks Internal assessment)

Suggested Readings

Entomology

1. Imms General text book of Entomology, Eds. O. W. Richards and R. G. Davis Chapman and Hall, London.
2. General and Applied Entomology, K.K. Nayar, T. N. Ananthkrishan and B.V. Davis Tata McGraw-Hill Co.Ltd. Bombay.
3. The Insect: Structure and function, R.F. Chapman, Cambridge University Press.
4. The Physiology of Insect , Ed. M.Rockstein ,Vol, 1-5, Academic Press, New York.
5. The Physiology of Insect Reproduction, F, Englemann, Pergamon Press, New York.
6. Comprehensive Insect Physiology , Biochemistry and Pharmacology , Eds. G.A. Kerkut and I. A. Gillberd, VOL. 1-13, Pergamon Press, New York.
7. Analytical Biochemistry of Insect, Ed. R. B. Turner, Elsevier, Amsterdam.
8. Insect Hormone, M. J. A. Novak. Chapman and Hall, London.
9. Modern Entomology(Second edition): D. B. Tembhare, Himalaya Publication House, Bombay.
10. Destruction and Useful Insect, Their Hanits and Control, C. L. Metcalf, W. P. Flint and R. I. Metcalf, Mc Grow I Ill Co. New York.
11. Integrated Pest Management, J.L. Apple and R. E. Smith, Plenum Publication Co., New Delhi.
12. An Introduction Of Biological Control RVD Boarscho, P. S. Y. Messenger and A. P. Gaiter, Plenum Publication Co.
13. Text Book of Entomology, K. P. Shivastava, Vol. 1 And 2 Kalyani Publication, Ludhiana.
14. Agriculture Entomology, H. S. Dennis, Timber Press Inc.

15. Entomology and Pest Management, Larry P. Pedigo, Prentice Hall.
16. Text Book of Agriculture Entomology, Alford V. David, Blackwell Science.
17. Biopesticides In Insect Pest Management, S. J. Ignacimulha and Alok Sen , Phoenix Publishing House Pvt, Ltd.
18. Biotechnology in Invertebrate Pathology and Cell culture (Maramorosch, K. ed.). Academic Press, New York.
19. PEBFANS (2003)” (Solomon Raju, A. J. ed.). Andhara University Press, Visakhapatnam.
20. Living Resources for the Millennium 2000 (S. J. William ed.), Students Offset Press, Chennai.

Semester- IV, Practical-VII, Special Group-Fish and Fisheries

1. Elementary work on surgical ablation with reference to gonads with the help of ICT tools/ charts/ models / photographs etc.
2. Study of normal differential count in fish blood (Source of fish blood: Local recognized fish markets).
3. Effect of stress (cold) on differential count in fish blood (Source of fish blood: Local recognized fish markets).
4. Effect of stress (hot) on differential count in fish blood (Source of fish blood: Local recognized fish markets).
5. Estimation of protein in blood serum of fish (Source of fish blood: Local recognized fish markets).
6. Separation of proteins based on molecular weight by SDS-PAGE.
7. Study of permanent histological slides of various fish organs & endocrine glands with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
8. Study of skeletal system of *Wallago* & *Labeo* with the help of already available skeleton/ ICT tools/ charts/ models / photographs etc.
9. Study of weberrian ossicles in *Heteropneustes fossilis*, *Clarias batrachus* & *Wallago* with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
10. Study of accessory respiratory organs in some air breathing fishes with the help of already preserved material/ ICT tools/ charts/ models/ photographs etc.
11. Assessment of maturity of gonads using already available preserved specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc

Distribution of Marks:**Total Marks:80**

1. Anatomical Observation Surgical ablation of gonads	25
2. Anatomical Observation	10
3. Physiology Experiment	15
4. Spotting	15
5. Viva voce	10
6. Practical Record	05

80**Internal Assessment** 20-----
Total marks 100**Project work** 100

(80 marks project evaluation including viva + 20 marks Internal assessment)

Suggested Readings:

1. Fish Physiology Vol. 1 to 13: Hoar H.S. & Randall (Eds.) (1964-1994) Academic press London, New York.
2. The physiology of fishes Vol. 1&2: Brown M.E.(1957) Academic press, New York.
3. Natural history of fishes & systematic of fresh water fishes :P Datta Munshi, J.S. & Shrivastva, M.P.(1988): Narendra pub. House, Delhi.
4. Air breathing fishes of India- Their structure, function and life history : Dutta Munshi,J. S., Hunghe G.M. (1992) .Oxford and JBH publication Co. New Delhi.
5. The freshwater fishes of India, Pakistan, Bangladesh, Burma and Shri Lanka Handbook: Jayaram, K.C. (1981): Zoological Survey of India, Calcutta.
6. Fish migration: Jones, F.R. S. (1968), E.Arnold, London
7. Aquaculture, Bardach, Ryther and Mc Lamy
8. Marine fisheries: D. K. Dal, K. V. Rao
9. Ichthyology: Lagler, K. F., Bardach, J. and Miller, R.(1977) John Wileys and sons.
10. Fish Endocrinology: Matty, A. J. (1985), Chapman and Hall, London.
11. An aid to the identification of common commercial fishes of India and Pakistan:Mishra K. S. (1982).
12. Aquaculture: The farming and husbandry of freshwater and marine organism: Bardach, J.E. (1974). Narendra Publication House, New Delhi.
13. Handbook of breeding of Indian Major Carps by pituitary hormone injection: Chonder,S. L. (1970). Satish book enterprises, Agra.
14. Diseases of fish: Duijin, C:Van Inr. (1973), life books London.
15. Fish and fisheries of India: Jhingran , V. G. (1985). Hindustan Publication Company, New Delhi.
16. Prawns and prawn fisheries of India: Kurian, C.V. and Sebastian, V. O. (19876) . Hindustan Publication Company, New Delhi.
17. The Sea food Industry: Martin, R. E.(1990). Narendra Publication House, New Delhi.
18. Ecological effects of water, applied limnology and pollutant effect: Welch, E. B. (1992).
19. A compendium of aquaculture technologies: Sinha, V.R. P.(1993). Oxford and JBH publication Co. New Delhi.

**Semester –IV Practical- VII,,
Special Group- Aquaculture**

- 1) Study of feeding habits of herbivorous, carnivorous and omnivorous fish by gut content analysis with the help of ICT tools/ models/ charts/ photographs etc.
- 2) Identification of egg, spawn, fry and fingerlings of Indian carps.
- 3) Preparation of artificial fish feed.
- 4) Anatomical observations, demonstration and detailed explanation of reproductive system of carps with the help of ICT tools/ models/ charts/ photographs etc.
- 5) Identification and classification of palaemonoid prawns, crabs, bivalves, larvivorous and aquarium fishes.
- 6) Short term bioassay and determination of LC₅₀ for fish exposed to pollutant. .
- 7) Study of pathological changes in gills, liver, kidney and intestine of fish exposed to heavy metals or pesticides with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 8) Biochemical estimation of proteins, lipids, glycogen, DNA and cholesterol.
- 9) Preparation of bacteriological media and determination of bacterial plate count for skin and gut with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 10) Gram staining of bacteria.
- 11) Visit to a fish market and collection of fish landing data.

Distribution of marks Total Marks:80

1) Analysis of gut content / preparation of artificial fish feed	10
2) Study of pathological changes in gills, liver, kidney and intestine	10
3) Biochemical estimation / determination of bacterial plate count.	10
4) Gram staining	05
5) Identification of spots (1 to10)	20
6) Dissection / Permanent mounting	10
7) Practical record & submission	10
8) Viva – voce	05

80

Internal Assessment 20

Total marks 100

Project work 100

(80 marks project evaluation including viva + 20 marks Internal assessment)

Suggested Readings

1. A textbook of fishery science and Indian fisheries- S. B. L. Srivastava
2. Fish and fisheries – Kamleshwar Pandey and J. P Shukala
3. A textbook of fish biology and fisheries – S.S. Khanna and H. R. Singh
4. A text book of fish biology and Indian fisheries- R.P. Parihar
5. General and Applied Ichthyology- S.K.Gupta and P.C.Gupta
6. An introduction to fishes- S. S. Khanna.
7. Fish processing technology – T. K. Govindon.
8. Hand book of breeding of major carps by pituitary hormones – S. L. Chonder.
9. Aquaculture – T. V. R. Pillay.
10. Diseases of cultivable freshwater fishes and their control – N. M. Chokraborty.
11. Fish and fisheries in India - V. G. Jhingran.
12. Indian fishes (Identification of Indian Teleosts) – T. A. Qureshi.
13. Introduction to tropical fish assessment per share, Erik Ursine and Siberian C. Verma.
14. Fish population dynamics – M. Devaraj.

**Semester-IV, Practical- VII,,
Special Group-Environmental Biology**

1. Bioassay test- toxicity evaluation of heavy metals/pesticides using snail/fish as test animals, determination of LC₅₀ value with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
2. Determination of oxygen consumption in normal fish/snail at different temperature.
3. Alteration in the oxygen consumption of fish / snail exposed to pollutants (heavy metals / pesticides).
4. Estimation and proximate composition (Protein / glycogen) in normal and treated fish / snail. (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)
5. Determination of NO₂ and SO₂ in ambient air.
6. Determination of suspended particulate matters in ambient air.
7. Determination of oil and grease by Soxhlet apparatus and separating funnel.
8. Identification of common commercial important inland / marine fishes, Crustaceans and mollusc.
9. Identification of maturity stages in fish.
10. Determination of gonadosomatic index.
11. Study of fecundity of fish.
12. Physicochemical analysis of Soil, pH, moisture.
13. Field work and study tour:
 - a) Visit to National Institute / Centre of Aquaculture.
 - b) Visit to a fish farm
 - c) Visit to National park / sanctuary to observed wildlife and maintaining the field diary.
 - d) Study tour and visit to national Institute of Oceanography.

Distribution of Marks Marks

1. Major experiment	15
2. Minor experiment	10
3. Minor experiment	10
4. Identification and comments on given spots (1-10)	30
5. Class record	10
6. Viva voce	05

	80
Internal Assessment	20

	Total marks 100

Project work 100

(80 marks project evaluation including viva + 20 marks Internal assessment)

Suggested Readings

1. The Science of Ecology: Brewer, A. (1998), Sanders Pub. New York.
2. The Science of Ecology: Ehrlich, P. R. & Roughsrden, J. (1987) McMillan Pub. Co. New York.
3. Population Biology: Emlein, J. M. (1984). McMillan Pub. London.
4. Current Ecology: Pattern & Progress: Killawa, J. & Anderson, G.J. (1986), Blackwell Science Publication, Oxford.
5. Basic Ecology: Odum, E. P. (1983), Sanders Pub. New York.
6. Systems of Ecology: Odum, H. T. (1983), John Wiley & Sons, New York.
7. Ecology with Special Reference to Animals and Man: Kendelgh, Prentice Hall Co.
8. National Resources & Conservation: Owen, O. S. (1985) McMillan Pub. New York.
9. Elements of Ecology: Smith, R. L. (1986), Harper & Row Pub. New York.
10. Environmental Physiology: Sonim, N. B. (1974), C. V. Mosby Pub. St. Louis, USA.
11. Environmental Physiology: Philips, J. G. (1975), Blackwell Science Publication, Oxford.
12. Ecology: Ricklefts, R. E. (1973), Thomas Nelson & Sons Ltd.
13. Threatened Animals of India: Tikader, B. K. ZSI Calcutta.
14. Ecology & Field Biology: Smith, R. L. Harper & Rw Pub. New York.
15. Wildlife in India: Sharin, V. B. (1985), Natraj Pub. Dehradun.
16. Fresh Water in India: Kulkarni, K. H. (1957), ICAR, New Delhi.
17. Marine Fishes: Bal, D. V. & Rao, K.V. (1989), Tata McGraw Hill, New York.
18. Textbook of Marine Ecology: Balkrishnan, N. A. & Thumpy, D. N. (1980), McMillan Co.
19. Marine Ecology & Fishes: Cushly, B. H. (1980), Cambridge University Press.
20. Treatise on Limnology: Hutchinson, G.E., (1967), John Willy Pub. New York.

21. Methods of Soil Analysis: De, S. K. (1962), Narayan Pub. House, Allahabad.
22. Fish & Fishes of India: Jhingran, V. G. (1985)
23. **Aquatic Pollution:** Edward A. (2000) Laws. 3rd edition. **John Wiley and Sons**, New York.
24. A Manual of Fresh Water Ecology: Santhanam, R., Velayntan, P. & Jagathesan, G. (1989), Daya Pub. House, Delhi.
25. Limnology: Welch, P. S. (1957), McGrall & Hill Co. New York.
26. **Air Pollution: Perkins, H.C.**, (1974) McGraw-Hill, New York.