

**M.Sc. Final
Zoology**

3 Hours Duration

100 Marks

- Paper I Biology of Chordates (each Paper)
Paper II Environmental Biology and Ethology
Paper III Genes and Differentiations
Paper IV Tools and techniques in Biology
Paper V Special Paper
Paper VI Special Paper
Laboratory Exercises
Demonstration and tutorials
SEMINAR

PAPER I : BIOLOGY OF CHORDATES

Duration : 3 Hours

Max. Marks - 100

Periods : 70

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Question paper will have 5 (five) questions in all having equal marks.

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- ii. Question numbers 2 and 3 will consist of only short answer type questions with 4 subdivisions of 5 marks each. There will be internal choice in these question.

iii. Question numbers 4 and 5 will be long answer type questions with internal choice.

1. Origin and outline classification of the chordates. 3
2. Interrelationships of Hemichordata, Urochordate and Cephalochordata and their relations with other deuterostomes. 5
3. Neoteny 8
4. Origin, evolution and adaptive radiation of Chordates. 20
 - 4.1 Geological time-scale and fossils.
 - 4.2 Origin, evolution and general characters of Agnatha (Ostracoderm and Cyclostomes).
 - 4.3 The early Gnathostomes (Placoderms).
 - 4.4 A general account the Elasmobranchii, Holocephali, Dipnoi and Crossopterygii.
 - 4.5 Adaptive radiation in bony fishes.

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- 4.6 Origin evolution and adaptive radiation of Amphibia.
- 4.7 Origin and evolution of Reptiles. The conquest of land; Seymouria and related forms cotylosauria, basic type and related forms, Cotylosauria, basic types and outline classification of reptiles.
- 4.8 Living Reptiles: a brief account of Rhynchocephalia. Chelonia, Crocodilia and Squamata.
- 4.9 Origin and evolution of Birds
- 4.10 Origin of flight: Flight/adaptation.
- 4.11 Origin of Mammals.
- 4.12 Evolution of man: Relationship of man with other primates. 10
6. Organogenesis
7. Embryonic adaptations 10
- 7.1 Evolution of the cleidoic egg, its structural and physiological adaptations.
- 7.2 Development and physiology of extra-embryonic membranes in amniotes.
- 7.3 Evolution of viviparity.
- 7.4 Development, types and physiology of the mammalian placenta.
8. Metamorphosis in Amphibia
- 8.1 Structural and physiological changes during metamorphosis,
- 8.2 Endocrine control of metamorphosis.
9. Regeneration 5
- 9.1 Type of regeneration (physiological, reparative and compensatory hypertrophy) regenerative ability in chordates.
- 9.2 Morphological and histological process in amphibian limb regeneration.
- 9.3 Origin of cell for regenerations and differentiation.

Suggested Reading Material :

1. Alexander, R.M.: The Chordata, Cambridge University Press, London.
2. Barrington, E.J.W. : The Biology of Hemichordata and Protochordata, Olter and Boyed, Edinbough.
3. Bourne, G.H.: The Structure functions of nervous tissues academic press, New York.
4. Carter, G.S.: Structure and Habit in Verterate Evolution sedwick and Jackron, London.

5. Eccles, J.C. : The understanding of the Brain. McGraw Hill Company new York.
6. Kingsley, J.S. : Outlines of Comparative Anatomy of Vertebrates Central Book Depot, Allahabad.
7. Kent, C.G.: Comparative Anatomy of Vertebrates.
8. Malcom Jollie: Chordata Morphology, East-West press Pvt. Ltd. New Delhi.
9. Milton H: Analysis of Vertebrate Structure, John Wiley and Sons Ltd. New York.
10. Montelli. A.R.: The Chordates, Cambridge University Press, London.
11. Smith, H.S.: Evolution of Chordata Structure, Hold Rinehart and Winstoin, Inc. New York.
12. Sedgwick, A.A.: Text Book of Zoology. Vol-1
13. Tansley, K. : Vision in Vertebrate, Chapman and Hall Lid., London.
14. Torrey, T.W.: Morphogenesis of Vertebrates, Hohn Wiley & Sons, New York
15. Walters, H.E. and Sayles, L.D. : Biology of Vertebrates, Macmillan and Co., New York.
16. Romer, A.S.: Vertebrate Body, W.B. Saunders Company, Philadelphia.
17. Young J.Z. : Life of Vertebrates, The Oxford University Press, London.
18. Colbert. E.H.: Evolution of the Vertebrates, John Wiley & Sons, Inc., New York.
19. Romer, A.S.: Vertebrate Palentology, University of Chicago Press, Chicago.
20. Clark, W.K., : History of Primates, University of Chocago Press, Chicago.
21. Weichert, C.K. and Presch, W. : Elements of Chordate Anatomy. MacGraw Hill Bokk Cimpany, New York.
22. Messers, H.M.: An Introduction of Vertebrate Anatomy.
23. Montagna, W. : Comparative Anatomy, John Wiley & Sons, Inc., New York.
24. DeVeer, S.G.: Embryos and Ancestors, Claredon Press, Oxford.
25. Andrew, S.M.: Problems in Vertebrate Evolution, Academic Press, New York.
26. Waterman, A.J.: Chordata Structure and Function, MacMillan Co., New York.
27. Joysay, K.A. and Kemp. T.S.: Vertebrate, Evolution, Oliver and Boyd, Edinbourgh.
28. Lovtrup, S.: The Phylogeny of Vertebrate. John Wiley & Sons, London.
29. Barbiur T. Hongton : Reptiles and Amchibians : Their Habitats and Adaptations. Miffin Co. New York.
30. Andrevos, S.M., Miles, R.S., Walker, A.D.: Problems in Vertebrate Evolution, Academic Press, New York.

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Paper-II : Environmental Biology and Ethology

Duration : 3 Hours

Max. Marks - 100

Periods : 70

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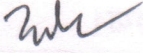
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Unit-1 : Environmental Biology

1. Interactions between environment and biota
 - a) Concept of habitat and ecological niches.
 - b) Limiting factors.
 - c) Energy flow, food chain, food web and trophic levels, ecological pyramids.
 - d) Biotic community: Concept, Structure, dominance, fluctuation and succession.
2. Ecosystem dynamics and management
 - a) Self sustaining mechanisms
 - b) Functional aspects and productivity concept.
 - c) Niche, ecotone, and overlapping of niches.
3. Environmental impact assessment
 - a) Environmental pollution.
4. Principles of conservation: Conservations strategies
 - a) Various natural resources.
 - b) Management
 - c) Preserving biological diversity with reference to India and Rajasthan and their sustainable management strategies.
5. Organization and dynamics of ecological communities.
 1. a) The habitat approach.
 - b) A detailed knowledge of communities of fresh water, marine, terrestrial and estuarine area with respect to
 - i. Extent
 - ii. Zonation
 - iii. Environment
 2. Ecosystem dynamics
 3. Interactions between environment and biota
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- iv. Biota
- v. Adaptations
- 6. The ecological outlook
 - a) Environmental ethics
 - b) Radiation (electromagnetic and ionizing) and environment
 - c) Global climatic changes (El Nino and La Nina)
 - d) Space ecology

Unit-II: Ethology

- 1. Introduction to the study of animal behavior
 - a) Aims of behavioural research
 - b) Diversity of animal behavior
 - c) Ethology: Historical perspective
- 2. Concepts of ethology
 - a) Fixed action patterns
 - b) Action specific energy
 - c) Sign stimulus
 - d) Innate releasing mechanism.
 - e) Learning and imprinting,
- 3. Proximate mechanisms in behavior/neuroethology
 - a) Introduction to neuroethology: Cellular mechanisms in behavior
 - b) Neural basis of sensory perception
 - c) Central neural processing
 - d) Neural basis of motor responses
 - e) Brain and behavior
 - f) Behavioural endocrinology
- 4. Spatial patterns, navigation and communication
 - a) Orientation, navigation, migration and channels of communication.
 - b) Physical properties of signals.
 - c) Field studies on primates: A preliminary knowledge.
 - d) Animal communication,
 - e) Pheremones; primer and releaser effects.
- 5. Social organizational orientation
 - a) Social organizations and its advantages.
 - b) Evolution of social systems.
 - c) Social groups of bees and mondeys

d) Learning:

- (i) abituIntroduction, definition and types
- (ii) Hation, trial and error and conditioning

Suggested Reading Material (Environmental Biology):

1. Begon, M. Harper, J.I. and Townsend, C.R. : Ecology, Individuals, Populations and Communities. Blackwell Science, Oxford University Press, Oxford.
2. Cherrett, J.M. : Ecological Concepts. Blackwell Scientific Publication, Oxford. U.K.
3. Elseth, B.D. and Baumgartner, K.M.: Population Biology, Van Nostrand Co., New York.
4. Orgenson, S.E. : Fundamentals of Ecological Modeling. Elsevies.
5. Krebs. C.J.: Ecology. Harper and Row. New York.
6. Krebs. C.J. Ecological Methodology. Harper and Row, New York.
7. Ludwig, J.A. and Reynolds, J.F.: Statistical Ecology, Johnwiley & Sons, New York.
8. Pianka. E.R.: Evolutionary Ecology, Harper and Row, New York.
9. Recklefs, R.E. and Miller, G Ecology, WII Freeman and company, New York
10. Swartzmen, G.L. and Kaluzny, S.P. Ecological Stimulation Primer, Macmillan, New York.
11. Danial. D. Chiras, Environmental Science (IX edition). Jones and Barlett (Student edition) Burlington
12. Mishra, R, Ecology Workbook. Scientific Publishers, Jodhpur (Raj.)

Ethology:

1. Rof, D.A.: The Evolution of Life Histories, Chapman and Hall, London, U.K.
2. Alcock, J.: Animal Behaviour: An Evolutionary Approach, Sinauer Assoc. Sunderland, Mass, USA.
3. Bradbury, J.W. and Vehren Camp. S.L. Principles of Animal Communications. Sinauer Assoc Sunderland Mass, USA.
4. Clutton- Brock, T.H. : The Evolution of Parental Care Princeton Univ. Press, Princeton, USA.
5. Eobi-Eibesfeldt, Holt 1: Ethology, The Biology of Behaviour, Rinehart and Winston, New York
6. Gould, J.L. : Mechanism of Evolution of Behaviour.
7. Hauser, M.: The Evolution of Communication, MIT Press, Cambridge, Mass. USA.
8. Hinde, R.A. : Animal Behaviour : A Synthesis of Ethology and Comparative psychology, McGraw Hill Company, New York.
9. Krebs, J.R. and Davis, N.V.: Behavioural Ecology, Blackwell Oxford, U.K.
10. Wilson, E.O.: Sociobiology: The New Synthesis. Harward University Press, Cambridge, Mass. USA

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Paper - III: Genes And Differentiation

Duration : 3 Hours

Max. Marks - 100

Periods : 70

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1. Introduction to animal development.
 - a) Problems of developmental biology.
 - b) Developmental patterns in metazoans.
 2. Creating multicellularity
 - a) Cleavage types.
 - b) Mesoderm and endoderm.
 3. Early vertebrate development
 - a) Neurulation and ectoderm.
 - b) Mesoderm and endoderm.
 4. Cytoplasmic determinants and autonomous cell specification
 - a) Cell commitment and differentiation
 - b) Germ cell determinants
 - c) Germ cell migration
 - d) Progressive cell-cell interaction and cell specification fate
 5. Body Axes
 - a) Establishment of body axes in mammals and birds
 - b) Proximate tissue interactions
 6. Homeobox concept in different Phylogenetic groups.
 7. Hormones are mediators of development
 - a) Amphibian metamorphosis
 - b) Insect metamorphosis
 9. Environmental evolution and animal development modularity
 - a) Environmental cues and effects.
 - b) Malformations and disruptions,
 - c) Changing evolution through development modularity.
 3. Early vertebrate development
 - a) Neurulation and ectoderm.
 - b) Mesoderm and endoderm.
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10. Biology of sex determination
 - a) Chromosomal sex determination - Mammals and Drosophila
 - b) Secondary sex determination in mammals.
 - c) Environmental sex determination.
11. Cell diversification in early embryo
 - a) Xenopus Blastomeres.
 - c) Totipotency & Pluripotency.
 - d) Embryonic stem cells.
 - e) Renewal by stem cells-epiderms
12. Hemopoietic stem cells
 - a) Stem cell disorders.
 - b) Blood cell formation

Suggested Reading Material

1. Development Biology S.F. Gibert, Sinauer Associates Inc., Massachusetts.
2. Ethen Bier, the Cold Spring : Cold Spring Harbour Laboratory Press, New York.

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- Suggested Reading Material
1. Development Biology S.F. Gibert, Sinauer Associates Inc., Massachusetts.
 2. Ethen Bier, the Cold Spring : Cold Spring Harbour Laboratory Press, New York.

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Paper-IV: Tools And Techniques In Biology

Duration : 3 Hours

Max. Marks - 100

Periods : 70

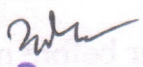
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Section A: Tools

1. Principles and application of
 - a) Light Microscopy and micrometry.
 - b) Phase contrast microscopy
 - c) Interference microscopy
 - d) Polarized microscopy.
 - e) Fluorescence & epifluorescence microscopy.
 - f) Transmission electron microscopy,
 - g) Scanning electron microscopy.
2. Principle and Application of
 - a) Ultracentrifugation. Differential and density gradient.
 - b) Electrophoresis: Various media for electrophoresis and various types such as paper, agrose, PAGE, submerged DNA electrophoresis, pulse chase electrophoresis, isoelectrofocussing points and capillary electrophoresis.
 - c) Chromatography: various types such as paper, TLC, GLC, HPLC, ion-exchange and affinity chromatography,
 - d) Freeze techniques: freeze-drying, freeze substitution, freeze fracture and freeze itch.
 - e) Lambert-Beers Law and colorimetry & spectrophotometry fluorescence, U.V., N.M.R., O.R.D./CD, ESR, IR, Atomic absorption, plasma emission spectrophotometry,
3. Principles and application of radiation techniques in Biology
 - a) Radiation dosimetry.
 - b) Radioisotopes and half life of isotopes.
 - c) Tracer techniques in biology.
 - d)
 - e)
 - f)
 - g)
4. Principles and application of radiation techniques in Biology
 - a) Ultracentrifugation. Differential and density gradient.
 - b) Electrophoresis: Various media for electrophoresis and various types such as paper, agrose, PAGE, submerged DNA electrophoresis, pulse chase electrophoresis, isoelectrofocussing points and capillary electrophoresis.
 - c) Chromatography: various types such as paper, TLC, GLC, HPLC, ion-exchange and affinity chromatography,
 - d) Freeze techniques: freeze-drying, freeze substitution, freeze fracture and freeze itch.
 - e) Lambert-Beers Law and colorimetry & spectrophotometry fluorescence, U.V., N.M.R., O.R.D./CD, ESR, IR, Atomic absorption, plasma emission spectrophotometry,
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 - f)
 - g)

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Section B: Techniques

1. Assay 2

- a) Chemical Assays.
- b) Biological Assays-in vivo and in vitro assays.

2. Principles of cytological and cytochemical techniques

- a) Fixation, chemical basis of fixation by formal dehyde, gluteraldehyde, chromium salts, mercury salts, osmium salts, alcohol and acetone.
- b) Chemical basis of staining of carbobydrates, proteins, lipids and nucleic acids.

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1. ENTOMOLOGY

Paper-V : Morphology and Physiology

Duration : 3 Hours

Max. Marks - 100

Periods : 90

1. Integument: Structure, composition and functions, biochemistry of sclerotization.
2. Functional Morphology of head, thorax and abdomen including head segmentation and appendages.
3. Muscular system.
4. Digestive system: Alimentary canal and physiology of digestion.
5. Circulatory system: Morphology
6. Respiratory system: Structure of respiratory organs and physiology. Adaptations for aquatic respiration.
7. Excretory system: Structure of excretory organs
8. Nervous system: Morphology
9. Neuroendocrine system: Morphology
10. Sense organs: Mechanoreceptors, Chemoreceptors auditory organs, sound and light producing organs, visual organs
11. Reproductive systems: Structure
12. Embryology: Structure of egg, embryonic and postembryonic development, types of larvae, pupae and metamorphosis, role of endocrine in growth and development, diapauses, viviparity and parthenogenesis.

1. ENTOMOLOGY

Paper -VI: Systematics, Ecology And Applied Entomology

Duration : 3 Hours

Max. Marks - 100

Periods : 90

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1. Classification of insects up to orders and suborders, basis and short history of classification. Introduction to primitive insects.
 2. Detailed classification of important and selected super families and families of the following orders. Orthoptera, Isoptera, Hemiptera, Coleoptera.
 3. Lepidoptera, Diptera and Hymenoptera.

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3. Social life in Isoptera and Hymenoptera.
4. Life cycle of Locusts and Aphids.
5. Origin and Evolution of insects with special reference to fossil - insects; causes of success of insects. 6. Ecology of Insects
 - 6.1 Effect of Physical factors.
 - 6.2 Intra-Interspecific relations,
 - 6.3 Population dynamics
 - 6.4 Host-Plant interactions
7. Biochemical adaptations to environmental stress (Metamorphosis, Diapause. Polymorphism etc.)
8. Concept of pest - How and Why an insect become pest?
9. History, damage caused and control of major pests of
 - 9.1 Cash crops: Sugarcane, Tobacco, mustard
 - 9.2 Cereal Crops : Wheat ,Paddy, Maize millet, sorghum, and Lentils.
 - 9.3 Pest of vegetable crops : Fruits and oil seed crops
 - 9.4 Cash fibre crops: cotton and sun hemp etc.
 - 9.5 Pests of Medical and veterinary importance with reference to role of WHO and UNICEF. Insect borne disease (A preliminary idea)
 - 9.6 Storage pest (stored grain and milled products with an elementary idea of different storage).
10. Pest control: Basic idea, EIL, and ETL.
 - 10.1 Various methods of pest control
 - 10.1.1 Prophylactic and cultural methods, quarantine regulations
 - 10.2 Physical control
 - 10.3 chemical control
 - 10.4 Biological control
 - 10.5 Chemistry and mode of action of insecticides

Inorganic insecticides, Organochlorine insecticides, organophosphorus compounds and carbamates.

- 10.6 Insecticides of plant origin
- 10.7 Synthetic pyrethroids
- 10.8 Insect growth regulators.
- 10.9 Microbial insecticide
- 10.10 Chemosterilant, repellent and antifeedents
- 10.11 Fumigants and fumigation

11. Social insects : Social organization, Caste Differentiation,

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2. Fish Biology

Paper-V: Morphology and Physiology of Fishes

Duration: 3 Hours

Max. Marks - 100

Periods: 90

Total No. of Lectures: 90

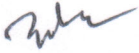
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1. Classification of fishes with special reference to evolutionary trends and adaptations.
 2. Integument and exoskeleton
 3. Fins : Types of fins structure, modifications and functions of fins.
 4. Food, feeding habits and feeding adaptations/behavior; structure of the alimentary canal and physiology of digestion and absorption.
 5. Blood vascular system : Structure of the heart; principal blood vessels and circulation of blood (elasmobranch, teleost and Dipnoi).
 6. Gills and aquatic respiration. Organization of gills in fishes: structure of a typical teleostean gill, physiology of gill respiration: gill ventilation, gill surface area, blood flow through gills, water blood barrier, gas exchange at the gill surface and gas exchange between blood and tissues
 7. Air breathing fishes; causative factors and structural adaptations.
 8. Structure and functions of the swimbladder.
 9. Water and electrolyte regulation in marine fresh water and euryhaline fishes.
 10. Structure and functions of the sense organs:
 - i) Eye: visual pigments and vision.
 - ii) Chemoreceptors: Olfactory and gustatory; biological significance of chemoreception.
 - iii) Labyrinth.
 - iv) Mechanoreceptors (lateral line organs.)
 11. Structure and physiology of the endocrine organs and tissues:
 - i) Pituitary
 - ii) Thyroid
 - iii) Gonads.
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- iv) Adrenal
 - v) Endocrine pancreas
 - vi) Bronchial
 - vii) Caudal neurosecretory cells and urophysis.
 - viii) Pineal.
12. Reproduction: Organs of reproduction; modes of reproduction; oviparity, viviparity hormonal and environmental regulation of reproduction. Aging and growth of fish.
 13. Reproduction behavior: Secondary sexual characters, nest building and parental care.
 14. Development: Types of eggs; fertilization; hatching and metamorphosis.
 15. Adaptations: Coloration, sound production, electric, organs, luminescent organs (location, structure, physiology and biological significance).
 16. Immune protection in fish systems and stress.
 17. Setting-up and maintenance of an aquarium.
 18. Fish products and byproducts; Liver oil, body oil, meal, fish manure, guano, glue, isinglass, roc (caviar), fins and leather.

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भरतपुर (राज.)

2. Fish Biology

Paper-VI: AQEACULTURE AND FISHERIES

Duration: 3 Hours

Max. Marks - 100

Periods: 90

Total No. of Lectures: 90

Note:- The theory paper of M.Sc. Final (Zoology) will have the following pattern.

Question paper will have 5 (five) questions in all having equal marks.

- i. Question number 1 will be compulsory and will have 20 very short answer question of 1 mark each.
 - ii. Question number 2 and 3 will consist of only short answer type questions with 4 subdivisions of 5 marks each. There will be internal choice in these questions.
 - iii. Question numbers 4 and 5 will be long answer type questions with internal choice.
1. Definitions of (a) inland, (b) marine (c) capture fisheries.
 2. Riverine fisheries: Ecology and fisheries of the major river systems, effects of dams and barrages on riverine fisheries.
 3. Estuarine fisheries: Ecology and fishery resource of major estuaries; potential and management of estuarine fisheries.
 4. Marine fisheries :
 - 4.1 Ecology and general survey of marine capture fishes with special reference to sardine, mackerel, Bombay duck and pomfret.
 5. Estimation of fecundity and population. Population dynamics and fishery catches.
 6. Growth and age; environmental factors and methods.
 7. Crustaceans and Molluscan fisheries (Marinewater, Brackishwater and Freshwater) culture of edible oyster and shrimps.
 8. Methods of Fishing: Crafts (non-mechanised and mechanized) and gears used in India for fishing in inland and marine water; recent advances in fishing method, electrical fishing: light fishing, fish finders (Eco-sounder and sonar) and their use.
 9. Transport and preservation of fish: Methods of transport, post-mortem changes and rigor mortis in fish; spoilage (bacterial and chemical); fish preservation-handling and cleaning of fresh fish, chilling, freezing, canning and pickling.
 10. Fishery management: fish yield, effect of fishing on yield and optimum catch; concept of a rational fishery.
 11. Environment and fish. Environmental factors (abiotic and biotic), interrelation to the life of fishes; pollution of aquatic ecosystems sources of pollution and nature of pollutants, effects of pollution on fisheries, legislative and other remedial measures to contain aquatic pollution.

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12. Freshwater fish culture in India; Fish seed resources (riverine, bundh breeding, hypophysation) hatching of eggs, hatchlings, 'hapas' and different types of hatcheries, management of hatcheries; methods of transporting fish seed, fingerlings and breeders; causes of mortality during transportation and measures for reducing it.
13. Planning and management of freshwater ponds for fish culture (freshwater fish-farming); survey of site, layout, soil and water requirements, preparation of nursery, rearing and stocking ponds, control of predators and weed fishes; liming and manuring; control of aquatic insects and weeds, procurement and segregation of fish seed; stocking rates; stocking ratios of different species for composite culture; artificial feed and supplement feeding, harvesting.
14. Culture of Indian major carps (rohu, catla and mrigal) exotic carps Common carp, grass carp, silver carp and tilapia. Composite culture principle, techniques and significance: Wet and dry bundh technique, induced breeding, hypophysation, selective breeding and hybridization.
15. Nutrition and physiological energetic: Nutritional requirement of fish with reference to proteins, lipids, carbohydrates, vitamins and minerals: essential amino acids and essential fatty acids; energy requirements: food conservation, efficient energy budgets.
16. Fish as food: Biochemical composition of raw fish, factors affecting biochemical composition of fish; nutritive value of raw and preserved fish; poisoning, toxicity and allergies from fish as food; quality control of fish as food.
17. Fisheries education, training and extension in India : Brief information about the objectives and functions of central Institute of Fisheries Education (Bombay) Central inland capture Fisheries Research Institute (Barrackpore) Central institute of Freshwater aquaculture (Chennai), National Bureau of Fisheries Genetics Resources (Allahabad). Central Institute of Fisheries Research Institute (Cochin), Central Institute of Fisheries Nautical and Engineering Training (Cochin), Central Institute of Fisheries Technology (Cochin) and National Institute of Oceanography (Dona Paula).

List of Practicals Exercises:

1. Study of distinguishing features, identification and classification of specimens of important species of fish available in the museum; Collection of local fish fauna and its identification upto the species level using taxonomic keys.
2. Anatomy and Histology:
 - a) Study of anatomy of teleost represented by the catfish wallago attu: External anatomy and gills, uiscera, alimentary canal and urinogivetal organs; musculature of gill ventilalion, and feeding; eye muscles and their innervations, endosketion (through dried and alizarin preparation).

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- Branchial blood vessels, brain and cranial nerves, swim bladder, weberian ossicles, membranous labyrinth connections.
- b) Preparation and study of stained permanent mounts of ampullae of Lorenzini (from *Dasyatis*), otolith, weberian ossicles, membranous labyrinth connections.
 - c) Dissection of air-breathing organs and their blood supply in *Anabas testudineus*, *Clarias batrachus*, *Heteropneustes fossilis* and *Channa sp.*
3. Preparation of microscopic slides of stained sections of following organs/tissues/structures from an adult teleost for their histological study of liver, intestine, kidney, testis, Ovary, gill, pituitary, thyroid tissue, head kidney (for interregional and chromaffin cells).
4. Physiology and biochemistry:
- a) Study of the effect of epinephrine, NaCl and KCl on fish chromatophores.
 - b) Study of changes in chromatophores of fish kept against white (light) and black (dark) backgrounds for protracted periods.
 - c) Determination of the rate of oxygen consumption (Winkler method) in a water breathing fish at different temperatures,
 - d) Determination of the rate of ammonia and urea excretion in fish,
 - e) Estimation of protein, fat, ash and water contents in fish muscle.
 - f) Study of free amino-acid pool in fish muscle through paper chromatography,
5. Basic Laboratory Techniques:

Maintenance of fish in freshwater: Setting up to an aquarium, quality of water in the aquarium and its aeration: Introduction of fish in the aquarium; feeding of fish and management of aquarium. Ecology: Physico-chemical analysis of water. Age and growth. Identification of maturity stages of fish; determination of gonosomatic index; estimation of fecundity; measurement of ova diameter.

Plankton. Benthos and Primary productivity: Collection of plankton and its qualitative and quantitative analysis; identification of common groups of freshwater plankton; collection and analysis of benthos from a freshwater fish pond, identification of mollusks, weeds, predatory fishes and harmful insects in a fresh water fish pond or lake by dark and light bottle method. Identification of important cultivable species of fish, their eggs and principal stages in their life histories.

preparation of pituitary gland extract; dosage and technique of injecting pituitary gland extract. Water Analysis; determination of water temperature light turbidity. Dissolved oxygen, dissolved carbon dioxide, ammonia, salinity, alkalinity, nitrates, phosphates, pH, particle size, available

Fish anesthetics and anesthetization; simple surgical procedure (gonadectomy), fish saline.

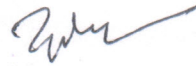
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Fieldwork and study tour

- a) A visit to a farm/fish seed production centre,
- b) 3 to 4 day tour to study various fisheries activities at selected centres/sites.

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