

2018-19

SYLLABUS

M.Sc. (FINAL) ZOOLOGY

Paper -I: BIOLOGY OF CHORDATES

3 Hours duration

Max. Marks: 100

Periods: 80

Note: - In M.Sc. Zoology Examination the theory paper have the following pattern.
Question paper will have 5 (five) questions in all having equal marks.

- i.) Question no. 1 will be compulsory and will have 20 very short answer questions of 1 mark each.
- ii.) Question no. 2 and 3 will consists of only short answer type questions with 4 subdivisions of 5 marks each. There will be internal choice in these questions.
- iii.) Question no. 4 and 5 will be long answer type questions with internal choice.

1. Origin and outline classification of the chordates.
2. Interrelationships of Hemichordata, Urochordata and Cephalochordata and their relations with other deuterostomes.
3. Life histories of sessile and pelagic tunicates, *Ascidia*, *Pyrosoma*, *Salpa*, *Doliolum* and *Oikopleura*.
4. Neoteny.
5. Origin, evolution and adaptive radiation of Chordates.
 - 5.1 Geological time – scale and fossils
 - 5.2 Origin, evolution and general characters of Agnatha (Ostracoderm and Cyclostomes).
 - 5.3 The early Gnathostomes (Placoderms).
 - 5.4 A general account of the Elasmobranchii, Holocephali, Dipnoi and Crosspterygii
 - 5.5 Adaptive radiation in bony fishes
 - 5.6 Origin, evolution and adaptive radiation of Amphibia
 - 5.7 Origin and evolution of Reptiles: The conquest of land; Seymouria and Cotylosauria, basic types and outline classification of reptiles
 - 5.8 Dinosaurs
 - 5.9 Living reptiles: a brief account of Rhynchocephalia, Chelonia, Crocodilia and Squamata.
 - 5.10 Origin and evolution of birds
 - 5.11 Origin of flight: Flight adaptations
 - 5.12 Origins of mammals: Primitive mammals (Prototheria and Metatheria).
 - 5.13 General account on adaptive radiations in Lutharian mammals
 - 5.14 Evolution of man: Relationship of man with other primates, fossil record of man's ancestry
6. Organogenesis

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- 6.1 Morphogenetic processes | epithelia and mesenchyme, organ formation.
- 6.2 Morphogenesis of the brain; neural crest cells and their accessory organs
- 6.3 Development of eye, heart and alimentary canal with accessory organs.
- 7. Embryonic adaptations
- 7.1 Evolution of cleidoic egg, it's structural and physiological characteristics.
- 7.2 Development and physiology of extra-embryonic membranes in amniotes.
- 7.3 Evolution of viviparity
- 7.4 Development, types and physiology of mammalian placenta
- 8. Metamorphosis in Amphibians
- 8.1 Structural and physiological changes during metamorphosis
- 8.2 Endocrine control of metamorphosis.
- 9. Regeneration
- 9.1 Types 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 cells for regenerations and differentiation.

Paper-II: ENVIRONMENTAL BIOLOGY AND ETHOLOGY

3 Hours duration

Max. Marks: 100

Periods: 80

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- 3. Question no. 4 and 5 will be long answer type questions with internal choice.

UNIT I - ENVIRONMENTAL BIOLOGY

- 1. Interactions between environment and biota
 - 1.1 Concept of habitat
 - 1.2 Limiting factors
 - 1.3 Energy flow, food chain, food web and trophic levels, ecological pyramids.
 - 1.4 Biotic community: concept, structure, dominance, fluctuation and succession.
 - 1.5 Various nutrient cycles in nature - carbon, nitrogen, phosphorus and water.
- 2. Ecosystem dynamics and management
 - 2.1 Complexity, stability and homeostasis of ecosystem.
 - 2.2 Functional aspects and productivity concept.
 - 2.3 Niche, ecotone and overlapping of niches.
 - 2.4 Character displacement, speciation and extinction.

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3. Environment impact assessment
 - 3.1 Environmental pollution.
 - 3.2 Population and impact of urbanization
4. Principles of conservation: Conservations strategies
 - 4.1 Various natural resources
 - 4.2 Present status and future needs
 - 4.3 Management
 - 4.4 Biodiversity of India and Rajasthan and their management.
5. Prospects and strategies for sustainable communities.
6. Organisation and dynamics of ecological communities
 - 6.1 The habitat approach
 - 6.2 A detailed knowledge of communities of terrestrial, fresh water, marine and estuarine areas with respect to
 - 6.2.1 Extent
 - 6.2.2 Zonation
 - 6.2.3 Environment
 - 6.2.4 Biota
 - 6.2.5 Adaptations
7. The ecological outlook
 - 7.1 Applied human ecology
 - 7.2 Radiation (electromagnetic and ionizing) and environment
 - 7.3 Climatic changes (El Nino and La Nina)
 - 7.4 Space ecology
 - 7.5 Human future

UNIT II – ETHOLOGY

1. Introduction to the study of animal behavior/ neuroethology
 - 1.1 Aims of behavioral research
 - 1.2 Diversity of animal behavior
 - 1.3 Ethology: Historical perspective
 - 1.4 Milestones in the study of animal behavior
2. Concepts of Ethology
 - 2.1 Fixed action patterns
 - 2.2 Action specific energy
 - 2.3 Sign stimulus
 - 2.4 Innate releasing mechanism
 - 2.5 Learning and imprinting
3. Proximate mechanism in behavior / neuroethology
 - 3.1 Introduction to neuroethology: Cellular mechanisms in behavior
 - 3.2 Neural basis of sensory perception

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- 3.3 Central neural processing
- 3.4 Neural basis of motor responses
- 3.5 Brain and behavior
- 3.6 Behavioral endocrinology
- 4. Ultimate mechanism in behavior and behavioralecology
 - 4.1 Examples of agonistic interactions among conspecifics.
 - 4.2 Hardy-Weinberg equilibrium and dispersal and inbreeding.
 - 4.3 Gametes and the evolution of mating and evolution of mating systems.
 - 4.4 Evolution of altruism and eusociality
 - 4.5 Human socio-biology, human ethology
 - 4.6 Mating and courtship behavior.
- 5. Spatial patterns, navigation and communication
 - 5.1 Orientation, navigation, migration and channels of communication
 - 5.2 Physical properties of signals
 - 5.3 Field studies on primates: A preliminary knowledge.
 - 5.4 Animal communication.
 - 5.5 Biological rhythm and its hormonal control
 - 5.6 Pheromones; primer and releaser effects.
- 6. Social organizational orientation
 - 6.1 Social organizations and its advantages
 - 6.2 Evolution of social systems
 - 6.3 Social groups of bees and monkeys
 - 6.4 Learning:
 - 6.4.1 Introduction and definition
 - 6.4.2 Types - Habituation, trial and error, conditioning
 - 6.5 Bird song learning behavior in the context of Tinbergen's 4 aims.
 - 6.6 Parental care in animals
 - 6.7 Aggression.

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Paper -III: GENES AND DIFFERENTIATION

3 Hours duration

Max. Marks: 100

Periods: 80

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3. Question no. 4 and 5 will be long answer type questions with internal choice.

1. Introduction to animal development
 - 1.1 Problems of development biology
 - 1.2 Develop patterns in metazoans
 - 1.3 Development in unicellular eukaryotes
2. Creating multicellularity
 - 2.1 Cleavage types
 - 2.2 Comparative account of gastrulation in vertebrates.
3. Early vertebrate development
 - 3.1 Neurulation and ectoderm
 - 3.2 Mesoderm and endoderm
4. Cytoplasmic determinants and autonomous cell specification
 - 4.1 Cell commitment and differentiation
 - 4.2 Cell specification in nematodes
 - 4.3 Germ cell determinants
 - 4.4 Germ Cell Migration (invertebrate & vertebrate)
 - 4.5 Progressive cell-cell interaction and cell specification fate.
5. Body Axes
 - 5.1 Establishment of body axes in mammals and birds
 - 5.2 Proximate tissue interactions
 - 5.3 Genetics of axis specifications in *Drosophila*
6. Homeobox concept in different phylogenetic groups
7. Tetrapod limb development
8. Hormones as mediators of development
 - 8.1 Amphibian metamorphosis
 - 8.2 Insect metamorphosis
 - 8.3 Ovarian luteinization and mammary gland differentiation.
9. Environmental evolution and animal development.
 - 9.1 Environmental cues and effects
 - 9.2 Malformations and disruptions.

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- 9.3 Changing evolution through development modularity
- 9.4 Developmental constraints
- 9.5 Creating new cell types-basic evolutionary mystery.
- 10. Biology of sex determination
 - 10.1 Chromosomal sex determination - Mammals and Drosophila
 - 10.2 Testis determining genes
 - 10.3 Ovarian development
 - 10.4 Secondary sex determination in mammals.
 - 10.5 Environmental sex determination
- 11. Cell diversification in early embryo
 - 11.1 Xenopusblastomeres
 - 11.2 Morphogen gradients
 - 11.3 Totipotency & Pluripotency
 - 11.4 Embryonic stem cells.
 - 11.5 Renewal by stem cells-epiderms
 - 11.6 Skeletal muscle regeneration
 - 11.7 Connective tissue cell family
- 12. Hemopoietic stem cells
 - 12.1 Stem cell disorders (Blood cells)
 - 12.2 Blood cell formation
 - 12.3 Bone marrow transplants
 - 12.4 Gene therapy

Paper-IV: TOOLS & TECHNIQUES IN BIOLOGY

3 Hours duration

Max. Marks: 100

Periods: 80

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Section A: Tools

1. Principle, construction and application of

1.1 Light Microscopy and micrometry

1.2 Phase contrast Microscopy

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- 1.3 Interference Microscopy
- 1.4 Polarized Microscopy
- 1.5 Fluorescence & epifluorescence microscopy
- 1.6 Electron Microscopy (TEM+SEM)
- 1.7 Confocal scanning and deconvolution microscopy
2. Principles and application of
 - 2.1 Ultracentrifugation: Differential and density gradient.
 - 2.2 Electrophoresis: Various media for electrophoresis and various types such as - paper, agarose, PAGE, submerged DNA, Pulse chase, isoelectric focusing points and capillary electrophoresis
 - 2.3 Chromatography: various types such as- paper, TLC, GLC, HPLC, Ion-Exchange and affinity chromatography.
 - 2.4 Freeze techniques: freeze drying, freeze substitution, freeze fracture and freeze etch.
 - 2.5 X-Diffraction
 - 2.6 Lambert-Beer's Law and colorimetry and spectrophotometry, fluorescence, UV, NMR, ORD/CD, ESR, IR, Atomic Absorption, plasma emission spectrophotometry.
 - 2.7 Flow cytometry / Fluorescence activated cell sorter.
3. Principle and application of radiations techniques in biology
 - 3.1 Radiation dosimetry
 - 3.2 Radioisotopes and half life of isotopes.
 - 3.3 Tracer techniques in biology
 - 3.4 Liquid scintillation.
 - 3.5 Cerenkov radiation
 - 3.6 Autoradiography

Section B: Techniques

1. Assay
 - 1.1 Definition and criteria of reliability.
 - 1.2 Chemical assays.
 - 1.3 Biological assay- in vivo and in vitro assays.
2. Principle of cytological and cytochemical techniques
 - 2.1 Fixation, chemical basis of fixation by formaldehyde, glutaraldehyde, chromium salts, mercury salts, osmium salts, alcohol and acetone.
 - 2.2 Chemical basis of staining of carbohydrates, proteins, lipids and nucleic acid
3. Principles and techniques of
 - 3.1 Nucleic acid hybridization and cot curve.
 - 3.2 Sequencing of proteins and nucleic acids.
 - 3.3 Blotting techniques (Southern, Northern and Western).
 - 3.4 Dot and Slot blots.
 - 3.5 Biotinylated DNA probe.

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- 3.6 Polymerase chain reaction (PCR)
- 3.7 Screening of genomic and cDNA libraries.
4. Principles and techniques of genetic engineering:-
 - 4.1 Basic techniques
 - 4.2 Cutting and joining of DNA molecules
 - 4.3 Changing genes: site Directed mutagenesis
 - 4.4 Analysis of DNA sequences
 - 4.5 Cloning strategies, gene library and cDNA
 - 4.6 DNA transformation techniques and their application in agriculture, health, medicine and industry.
 - 4.7 Introducing genes in animal cells.
 - 4.8 Application of recombinant DNA technology
 - 4.9 Hybridoma technology
 - 4.10 Transgenic animals.
5. Embryo technology
 - 5.1 Superovulation, cryopreservation, of spermatozoa.
 - 5.2 In Vitro fertilization
 - 5.3 Embryo sexing
 - 5.4 Chimera formation
 - 5.5 Gene transfer through embryo transgenesis
 - 5.6 Embryo transfer
 - 5.7 Assisted reproductive technologies
 - 5.8 Prenatal diagnosis and genetic counseling
6. Cell culture techniques
 - 6.1 Design and functioning of tissue culture laboratory
 - 6.2 Cell proliferation measurements
 - 6.3 Cell viability testing
 - 6.4 Culture media preparation and harvesting techniques.
7. Cryotechniques
 - 7.1 Cryopreservations for microscopy.
 - 7.2 Cryotechniques for microscopy.

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M.Sc. (Final) Zoology (2018)

PRACTICALS

General Papers:

I. Anatomy

(a) Major

(i) Cranial nerves of *Wallago attu*

(ii) Cervical nerves of Rat

(iii) Reproductive organs of Rat

(b) Minor

(i) Accessory respiratory organs of *Heteropneustes fossilis*(ii) Labrith organs of *Ambax testudens*

II. Study of Museum Specimens/Models/Charts/Digital media

Lower Chordates

Salpa: asexual and sexual stages, *Doliolum*, urozooids, *Beroë*, *Herdmania*, *Amphioxus*

Pisces

Petromyzon, *Myxine*, *Rhinobatus*, *Pristis*, *Trygon*, *Chimaera*, *Polydon*, *Acipenser*, *Amia*, *Lepidosteus*, *Protopterus*, *Lepidosteus*, *Neoceratodus*, *Notopterus*, *Exocoetus*, *Echeneis*, *Pleuronectes*, *Mastacanthus*, *Diodon*, *Tetradon*, *Ostracion*, *Lupus*, *Syngnathus*, *Hippocampus*, *Anguilla*, *Labeo*, *Ophiocephalus*

Amphibia

Ichthyophis, *Necturus*, *Proteus*, *Ambystoma*, *Axolotl*, Salamander, *Siren*, *Alytes*, *Pipa*, *Bufo*, *Hyla*, *Rhacophorus*, *Rana*

Reptilia

Testudo, *Chelone*, *Sphenodon*, *Crotalus*, *Hemidactylus*, *Phrynosoma*, *Draco*, *Varanus*, *Chamaeleo*, *Colelia*, *Hydrophis*, Ratle snake, Viper, Pit Viper, Krait, Eryx, *Gavialis*

Aves

Archaeopteryx, Lailor Bird, Indian Koe, Jungle Jow, Peacock, Columba, Parrot, Wood Pecker, Owl, Flamingo, Great Indian Bustard

Mammals

Ornithorhynchus, *Techina*, *Macropus*, Hedgehog, *Marmos*, *Loris*, Bat, Mongoose, *Hystrix*, Otter

III. Study of Microscopic slides:

Lower chordates

Herdmania spicules, *Herdmania* tadpole / larva, *Amphioxus*, T. S. passing through oral hood, pharynx, testes and ovary, intestine and caudal region, *Amphioxus* larva (whole mount)

Pisces

Placoid scale, cycloid scale, ctenoid scale

Amphibia

N. S. skin of frog, T. S. passing through stomach, duodenum, intestine, liver, pancreas, lung, kidney, testis, ovary, spinal cord, bone

Reptilia

V. S. skin of lizard

Aves

V. S. skin of bird, contour feather, down feather

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Mammals

V.S. skin of mammal, I.S. passing through stomach, intestine, liver, pancreas, kidney, testes, ovary, thyroid gland, adrenal gland, lung, bone and spinal cord, I.S. of pituitary gland, I.S. of simple cuboidal epithelium, simple columnar epithelium, simple squamous epithelium, adipose tissue and reticular tissues, blood smear

- IV. **Comparative Osteology (Models/Charts/Diagrams):**
Comparative account of axial and appendicular skeletons of Frog, Varanus, Pigeon and Rabbit (both articulated and disarticulated with the help of models, artificial skeleton and bones).
- V. **Tools and Techniques**
- Operations of various types of microscopes.
 - Use of Phase-contrast microscope.
 - Use of Fluorescence microscope and demonstration of nucleic acid by acridine orange or ethidium bromide.
 - Preparation of tissue for TEM.
 - Tissue homogenization and fractionation by differential centrifugation for isolation of mitochondria, nucleic acids and cytosol and use of marker enzymes for assessment of the purity of the components.
 - Demonstration of GLC, atomic absorption spectrophotometer, G.A.S.A etc.
 - Standardisation of oculometer and measurements of tubular diameter, cell heights, nuclear diameters, etc.
- VI. Exercises on Environmental Biology, Ethology and Developmental Biology can be framed as per the syllabus of the theory paper and infrastructure of the Department.

Practicals (M.Sc. Final, General Paper)
Scheme of Practical Examination.

Duration: 5 hrs.

Max. Marks: 100

Exercise

Marks

1. Anatomy	
a. Major	5
b. Minor	2
2. Ethology	9
3. Environmental Biology	10
4. Tools and Techniques	10
5. Embryology	10
6. Spotting (No. 1-8)	24
7. Practical record	10
8. Viva-Voce	10
9. Seminar	10
Total = 100	

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Notes:

1. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of charts/models/D-PCSP, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.
2. With reference to permanent preparations and microscopic slides, in case of non-availability, the exercise should be substituted with diagrams, photographs, models, charts etc.
3. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
4. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
5. Mounting material for permanent preparations would be as per the syllabus or as available through collection and culture methods.
6. It should be ensured that animals used in the practical exercise are not covered under the Wildlife Act 1972 and amendments made subsequently.

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BIOLOGY OF CHORDATES

SUGGESTED BOOKS

- The chordata, Alexander, R.M. Cambridge University Press, London.
- The Biology of Hemichordata and Protochordata. Barrington, E.J.W. Olter and Boyd. Edinbrough.
- Structure and Habit in vertebrate evolution - carter, G.S. Sedgwick and Jackson. London
- Comparative anatomy of vertebrates. Kent. C.G.
- Chordate morphology. Malcom Jollie. East-West Press Pvt.Ltd., New Delhi.
- Analysis of vertebrate structure. Milton Hilderbrand. John Wiley and Sons., Inc, New York
- Text Book of Zoology, Sedgwick, A.A. Students Vol.II.
- Vertebrate Body. Romer A.S. W.B. Saunders Co., Philadelphia.
- Life of vertebrate, Young. J.Z. The Oxford University Press. London.
- Life of mammals, Young. J.Z. The Oxford University Press. London.
- Evolution of the vertebrates, Colbert. E.H. John Wiley and Sons Inc., New York.
- Vertebrate Paleontology. Romer. A.S. University of Chicago Press, Chicago.
- Chordata structure and function. Waterman. A.J. Macmillan Co. New York.
- Vertebrate evolution. Joysey. K.A. and T.S. Kemp. Oliver and Boyd. Edinbrough.
- The Phylogeny of vertebrate. Lovtrup. S. John Wiley and Sons. London
- The biology of the Amphibia. Kingsley Noble G. Dover Publications. New York
- Avian Biology (in several volumes), Farner, D. S. and King, J. R., Academic Press, New York, 1971.
- Analysis of Vertebrate Structure, Hildebrand, M. 4th edition, John Wiley & Sons, Inc., New York, 1995.
- Biology and Comparative Physiology of Birds, Marshall, A. J., Volume I & II, 1960.
- Vertebrate Life, McFarland, W. N., Pough, F. H., Cade, T. J. and Heiser, J. B., Macmillan Publishing Co., Inc., New York, 1979.
- Text Book of Zoology, Parker, T. S. and Haswell, W. A., ELBS, 1978.

GENES AND DIFFERENTIATION

SUGGESTED BOOKS

- Development Biology S.F. Gilbert, Sinauer Associates Inc., Massachusetts
- Morphogenesis of vertebrate. Torrey, T.W. John Wiley and Sons Inc., New York and London.
- An Introduction to embryology, Balinsky, B.I.: W.B. Saunders Comp., ?
- Davidson, E.H.: Gene activity in early development. Academic Press, New York.
- Modern embryology, Bodemer, C.W.: Holt Chart and Winston, Inc. New York, Chicago
- Principle of Animal Developmental Biology. Geol, S.C. Himalaya Publishers 1984.
- Metamorphosis, Etkin, W.L.I. Gilbert.: North-Holland Co., Amsterdam.
- Developmental Biology. R.M. Twyman. Viva Books Private Limited. New Delhi.
- From egg to Embryo. Slack J.M.W. Cambridge University Press, Cambridge UK.
- Principles of Development. Wolpert, L. Oxford University Press, Oxford, UK.

ENVIRONMENTAL BIOLOGY AND ETHOLOGY

SUGGESTED BOOKS

- Ecological concepts. Cherrett, J.M. Blackwell Sci. Publ. Oxford U.K.
- Population biology. Elseth. B.D. and K.M. Baumgartner. Van Nostrand Co., New York

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- Fundamentals of ecological modeling. Jorgenson. SE. Elsevier. New "
- Animal behaviour: A synthesis of ethology and comparative psychology. Hinde. R.A. McGraw-Hill. New York.
- Behavioural ecology: Krebs J.R. and N.B. Davis: Blackwell. Oxford. U.K.
- Sociology: The new synthesis. Wilson. E.O. Harbard Univ. Press. Cambridge. Mass. USA
- A New Ecology - Systems Perspective Sven Erik Jørgensen, Brian Fath, Simone Bastianoni, Joao Marques, Felix Muller, S. Nors Nielsen, Bernard Patten, Enzo Tiezzi and Robert Ulanowicz Elsevier May 2007
- Ecological Census Techniques - A Handbook (2nd edition) Edited by William J. Sutherland CUP August 2006
- The Life of Mammals (Life of Mammals) by David Attenborough
- Alcock, John . Animal behaviour—an evolutionary approach. (Sinauer Associates). 547 pages.
- Barnard, C.J. . Animal behaviour. (Croom Helm, London). 340 pages.
- Barnett, S.A. . Modern Ethology.
- Chauvin, Remy . Ethology: The biological study of Animal Behavior. (International Univ. Press). 245 pages.
- Colgan, Patric W. . Quantitative Ethology. (John. Wiley & Sons). 364 pages.
- Immelman, C. Introduction to Ethology.
- Manning, Aubrey . An Introduction to animal behaviour. (Edward Arnold Publ., London). 208 pages.
- 18. Manning, Aubrey . An introduction to animal behaviour. (Addison-Wesley Publ. Co.). 294 pages.
- 19. McFarland, David. Animal behaviour: Psychology, Ethology & Evolution. (ELBS Publ.)
- 20. Slater, P.J.B. . Essentials of animal behaviour. (Cambridge Univ. Press). 233 pages.
- 21. Wallace,
- Fundamentals of Ecology by Eugene Odum, Gary W. Barrett, Hardcover: 624

TOOLS & TECHNIQUES

SUGGESTED BOOKS

- Principle and Techniques of Practical Biochemistry ; Wilson & Keith
Cambridge Publications
- Biotechniques; Theory and Practice ; SVS Rana Rastogi Publications, Meerut
- Clinical Biochemistry; Techniques and Instrumentation, JS Varcoe, World Scientific Publication Company, ISBN ; 978-981-02-4556-6

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SPECIAL PAPERS

PAPER-V: ENTOMOLOGY- INSECT MORPHOLOGY, PHYSIOLOGY

3 Hours duration

Max. Marks: 100

Periods: 80

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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 and physiology including composition of haemolymph.
 6. Respiratory system: Structure of respiratory organs and physiology. Adaptations for aquatic respiration.
 7. Excretory system: Structure of excretory organs and physiology of excretion.
 8. Nervous system: Morphology and physiology
 9. Neuroendocrine system: Morphology and physiology
 10. Sense organs: Mechanoreceptors, Chemoreceptor, Auditory organs, light producing organ, sound producing organ, visual organ and physiology of vision.
 11. Reproductive system. Structure and physiology.
 12. Embryology: - Structure of egg, embryonic and post embryonic development, Types of larvae, pupae and metamorphosis. Role of endocrine in growth and development, diapauses, viviparity and parthenogenesis.

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**PAPER-VI: ENTOMOLOGY - INSECT SYSTEMATIC, ECOLOGY AND
APPLIED ENTOMOLOGY**

3 Hours duration

Max. Marks: 100

Periods: 80

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 3. Question no. 4 and 5 will be long answer type questions with internal choice.
1. Classification of insects up to order and suborders, basis and short history of insect classification. Introduction to primitive insects.
 2. Detailed classification of important and selected super families and families of the following orders- Orthoptera, Isoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera.
 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 and inter specific relations.
 - 6.3 Population dynamics
 - 6.4 Insect plant interaction.
 - 6.5 Biochemical adaptations to environmental stress (Metamorphosis, Diapause, and Polymorphisms etc.).
 7. Concept of pest .How and why insects have become pests?
 8. Bionomics, distribution; mode of damage caused and management of major pests
Cash crops: sugar cane, tobacco and mustered, cotton. Cereal crops: wheat, paddy, millet, maize, sorghum, pulses. Pests of vegetables, fruits and oil seed crops.
 9. Pests of medical and veterinary importance and role of WHO and UNICEF.
 10. Storage pests (stored grains and milled products).
 11. Various methods of insect pest control: Physical, Mechanical, Chemical, Cultural, Quarantine regulations.
 12. Nomenclature and classification of insecticides.
 - 12.1 Concept of 1st, 11nd and IIIrd generation pesticides
 - 12.2 Pesticides act of India.
 - 12.3 Selection of insecticides, their formulation and mode of action.
 - 12.4 Preventive measures and antidotes.

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- 12.5 Fumigants and appliances used for application of insecticides. Hazards involved and safe handling of insecticides.
- 12.6 Mechanism of insecticides resistance in insects. Insecticide synergists and antagonist.
13. Biological control: Definition, biological control agents; Advantages and disadvantages of biological control.
14. Integrated pest management (IPM)
15. Dynamics of environmental pollution.
16. Pesticides: Their impact on wild life; Their impact on human health (bio accumulation, bio magnification, biodegradation)
17. Forensic entomology with special reference to man and wild life.
18. Beneficial insects (silk worm, honey bee, lac insect and industries related to them).

FISH BIOLOGY

PAPER – V: FISH BIOLOGY

3 Hours duration

Max. Marks: 100

Periods: 80

Note: - In M.Sc. Zoology Examination the theory paper have the following pattern.

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

1. Question no. 1 will be compulsory and will have 20 very short answer questions of 1 mark each.
2. Question no. 2 and 3 will consists of only short answer type questions with 4 subdivisions of 5 marks each. There will be internal choice in these questions.
3. Question no. 4 and 5 will be long answer type questions with internal choice.

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. Locomotion: Locomotor muscle, the red (slow) and white (fast) muscle fiber types; modes of swimming and hydromechanics of propulsion; role of fins in swimming; significance of swim bladder in swimming; non swimming locomotion.
5. Food, feeding habits and feeding adaptations/behavior; structure of the alimentary canal and physiology of digestion and absorption.
6. Planktons: Classification, common organism and their importance; algal bloom, nutrient cycle, trophic levels and energy flow

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7. Blood vascular system: Structure of the heart: principal blood vessels- and circulation of blood (elasmobranches, teleost and Dipnoi).
8. 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.
9. Air-breathing fishes: causative factors and structural adaptations.
10. Structure and functions of the kidney: nitrogenous end products and pattern of their excretion
11. Water and electrolyte regulation in marine, freshwater and euryhaline fishes
12. Structure and functions of the swim-ladder.
13. Study of feeding habits of fish through qualitative and quantitative analysis of gut contents of herbivores, carnivores and omnivorous species.
14. Nervous system: Structure and functions of the central. Peripheral and autonomic nervous systems; anatomy and function of the Mauthner neurons.
15. Structure and functions of the sense organs: Eye: visual pigments and vision. Chemoreceptors: Olfactory and gustatory biological significance of chemoreception. Labyrinth. Mechanoreceptors (lateral line organs).
16. Structure and physiology of the endocrine organs and tissues: Pituitary, Thyroid, Gonads, Adrenal, Endocrine pancreas, Ultimobranchial, Caudal neurosecretory cells and urophysis, Pineal.
17. Reproduction: Organs of reproduction; modes of reproduction viviparity, hormonal and environmental regulation of reproduction.
18. Reproductive behavior: Secondary sexual character. Nest building and parental care.
19. Development: Types of eggs; fertilization; hatching and metamorphosis.
20. Adaptations: Coloration, sound production, electric organs, luminescent organs (location, structure, physiology and biological significance).
21. Adaptations in deep sea. Hill-stream and cave-dwelling fishes, freezing avoidance in arctic and Antarctic fishes.
22. Migration: its types and causes.
23. Fish pathology: Symptoms, etiology, prophylaxis and treatment of common diseases and pathological conditions in cultivable fish.
24. Setting-up and maintenance of an aquarium.
25. Fish products and byproducts: Liver oil, body oil, meal, fish manure, guano, glue isinglass, roe(caviar), fins and leather.

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FISH BIOLOGY

PAPER-VI: AQUACULTURE AND FISHERIES

3 Hours duration

Max. Marks: 100

Periods: 80

Note: - In M.Sc. Zoology Examination the theory paper have the following pattern.
Question paper will have 5 (five) questions in all having equal marks.

1. Question no. 1 will be compulsory and will have 20 very short answer questions of 1 mark each.
 2. Question no. 2 and 3 will consists of only short answer type questions with 4 subdivisions of 5 marks each. There will be internal choice in these questions.
 3. Question no. 4 and 5 will be long answer type questions with internal choice.
1. Definitions of (a) inland, (b) marine (c) capture (d) culture fisheries.
 2. Riverine fisheries- Ecology and fisheries of the major river systems; effects of dams and barrages on riverine fisheries.
 3. Reservoir fisheries: Location, ecology and fisheries of some important reservoirs: development, exploitation and management of reservoir fresh water fisheries.
 4. Cold water fisheries - ecology of high altitude streams, lakes and reservoirs; present status and scope for important cold water fisheries.
 5. Estuarine fisheries- Ecology and fishery resources of major estuaries; potential and management of estuarine fisheries.
 6. Marine fisheries:
 - 6.1 Ecology and general survey of marine capture fisheries with special reference to sardine, Mackerel, Bombay duck and pomfret.
 - 6.2 Offshore and deep sea fishery potential in EEZ (exclusive Economic Zone).
 7. Estimation of fecundity and population. Population dynamics and fishery catches
 8. Growth and age; environmental factors and methods
 9. Crustaceans and Molluscan fisheries (Marine water, Brackish water and fresh water)
 10. Methods of fishing: Crafts (non-mechanised and mechanized) and gears used in India for fishing in inland and marine water; recent advances in fishing methods, electrical fishing; light fishing, fish finders (Eco-sounder and sonar) and their use.
 11. Transport and preservation of fish: Methods of transport, postmortem changes and rigor mortis in fish; spoilage(bacterial and chemical); fish preservation- handling and cleaning of fresh fish, chilling, freezing, quick freezing, use of chemicals and antibiotics, irradiation, salting, drying, freeze-drying, smoking, canning and pickling.
 12. Fishery management: fish yield, effect of fishing on yield and optimum catch, concept of national fishery.
 13. Ecology and productivity of fresh water lake and perennial fish-pond indices of productivity; physical and chemical characteristics of water, nature and fertility of the soil.

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14. 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.
15. Fresh water 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.
16. Planning and management of freshwater ponds for fish culture (fresh water 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 ratios of different species for composite culture; artificial feed and supplement feeding, harvesting.
17. 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.
18. Cold-water culture of trout: maser, culture method and management.
19. Larvivorous fishes and their importance.
20. 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.
21. 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.
22. 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 fresh water aquaculture (Chennai), National Bureau of Fisheries Genetics Resources (Allahabad), Central Marine 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)

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