

M.Sc. Sem. I to IV
(Zoology)

Prospectus No. 2012127

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SANT GADGE BABA AMRAVATI UNIVERSITY

विज्ञान विद्याशाखा
(FACULTY OF SCIENCE)

अभ्यासक्रमिका
विज्ञान पारंगत परिक्षा (प्राणिशास्त्र)
सत्र १ ते ४

PROSPECTUS
OF
MASTER OF SCIENCE EXAMINATION
IN
ZOOLOGY
Semester -I & III Winter 2011,
Semester -II & IV Summer 2012,



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**Syllabus Prescribed for
M.Sc. (Zoology). Semester I
Paper I
ANIMAL STRUCTURE AND FUNCTION (NON-CHORDATA)**

- Unit I 1.0 **Organization of Protozoa, Porifera and Metazoa**
- 1.1 Protozoa – Size, shapes, colonial forms, protoplasm, surface, ectoplasm and endoplasm. Protoplasmic grade of organization.
 - 1.2 Structural organization of cilia. Flagellar and ciliary movements in protozoa.
 - 1.3 Parazoa- Skeleton and canal systems in sponges. Cellular grade of body -Organization in Porifera.
 - 1.4 Metazoa—Cell-tissue grade organization in Coelenterates and Ctenophora
 - 1.5 Tissue –organ grade organization in Platyhelminthes. Organ-system grade Organization in higher metazoan and Body cavities.
 - 1.6 Organization of body cavities in-Acoelomates, Pseudocoelomates and Coelomates – (protostomia and deuterostomia).
 - 1.7 Significance of coelom in metazoa.
- Unit II
- 2.1 Patterns of feeding in lower metazoan.
 - 2.2 Filter feeding in Polychaeta.
 - 2.3 Filter feeding in Mollusca.
 - 2.4 Filter feeding in Echinodermata.
 - 2.5 Principles of hydrostatic movements.
 - 2.6 Hydrostatic movements in Coelenterates ,Annelids and Echinodermata
- Unit III
- 3.1 Organs of respiration—Gills, Book-lungs and Trachea.
 - 3.2 Respiratory pigments in invertebrates.
 - 3.3 Mechanisms of respiration in Mollusca and Arthropoda.
 - 3.4 Organs of excretion in Platyhelminths, Annelida and Arthropoda.
 - 3.5 Nature of excretory products; coelom and coelomoducts
 - 3.6 Mechanism of excretion in invertebrates
 - 3.7 Ionic regulation in invertebrates.
- Unit IV
- 4.1 Primitive nervous system in Coelenterata and Echinodermata.

- 4.2 Advanced nervous systems in Annelida, Arthropoda (crustacea and insecta) , and Mollusca (cephalopoda)
 - 4.3 larvae in free living Porifera, Coelenterata and Annelida.
 - 4.4 Larval forms of Crustacea, Mollusca and Echinodermata.
 - 4.5 Larval forms of helminth parasites.
 - 4.6 Evolutionary significance of larval forms.
- Unit V **General topics**
- 5.1 Parasitic protozoa.
 - 5.2 Concept and significance of Minor Phyla.
 - 5.3 Metagenesis and Polymorphism in Coelenterata.
 - 5.4 Structural adaptations in insects for different environments.
 - 5.5 Role of Neurohormones in crustaceans.

**M.Sc. (Zoology). Semester - I
Paper II
ANIMAL STRUCTURE AND FUNCTION (CHORDATA)**

- Unit I
- 1.1 Classification of chordates – Evolutionary concepts of classification. Traditional and Cladistic classification. Origin of Chordata.
 - 1.2 Classification and phylogeny of vertebrates. Origin of Vertebrata.
 - 1.3 Affinities of Chordata with Hemichordata, Cephalochordata and Urochordata.
 - 1.4 Adaptive radiations in Mammals.
 - 1.5 Epidermis, dermis and hypodermis of vertebrate integument. Development and General structure of skin. Epidermal derivatives-(Glands, feathers, hairs, hoofs, horns, scales, claws, nails etc.), Functions of skin.
- Unit II
- 2.1 Evolution of aortic arches.
 - 2.2 Generalized scheme for gill breathing organs in- primitive vertebrates (chondrichthyans and actinopterygians),lung fish, adult anurans, primitive amniote condition as found in lizard, advanced amniote condition as found in mammals.
 - 2.3 Evolution of cardiovascular system (heart), Structural evolution of lungfish and amphibian cardiovascular system.
 - 2.4 Evolution of urinogenital system in vertebrate series.
- Unit III
- 3.1 Respiratory organs in vertebrates.
 - 3.2 Mechanisms of respiration in aquatic, land and terrestrial habitats.

- 3.3 Vocalization.
- 3.4 Accessory respiratory organs and swim bladders in fishes.

Unit IV

- 4.1 Basic organization and functions of skeletal elements-Skull, notochord, vertebrae, ribs and appendicular skeleton.
- 4.2 Comparative account of jaw suspensorium.
- 4.3 Comparative account of vertebrae.
- 4.4 Comparative account of limbs and girdles.
- 4.5 Skulls in reptiles.
- 4.6 Mineralization-Calcification and bone formation

Unit V

- 5.1 Evolution of man.
- 5.2 Echolocation in Bats and Whales.
- 5.3 Flight adaptations in birds.
- 5.4 Migration in birds
- 5.5 Migration in fishes

Suggested Reading Material

1. Hyman, L.H. The invertebrates. Vol, 1 Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
3. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London,
4. Hyman, L.H. The invertebrates. Vol.2. Mc Graw Hill Co., New York.
5. Hyman, L.H. The invertebrates Vol.8. McGraw Hill Co., N. Y. and London.
6. Barnes, R.D. Invertebrate Zoology, III edition. W.B. Saunders Co., Philadelphia.
7. Russel-Hunter, W.D. A biology of higher invertebrates, the Macmillan Co. Ltd., London
8. Hyman, L.H. The invertebrates smaller coelomate groups, Vol., V. McGraw Hill Co., New York.
9. Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
10. Sedgwick, a.a. Student text book of Zoology. Vol, I, II and III. Central Book Depot, Allahabad.
11. Parker, T.J. Haswell, W.A. Text Book of Zoology, Macmillan Co., London.
12. Borradaile, L.A. and F.A. Potts: The Invertebrates: Asia Publishing House, Bombay, London
13. Nigam: Biology of non-chordata, S. Nagin Chand.

14. Alexander, R.M. The Chordata. Cambridge University Press, London.
15. Barrington, E.J. W. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh.
16. Bourne, G.H. The structure and functions of nervous tissue Academic Press, New York.
17. Carter, G.S. Structure and habit in vertebrate evolution-Sedgwick and Jackson, London.
18. Eccles, J.C. The understanding of the brain. Mc Graw Hill co., New York and London.
19. Kingsley, J.S. Outlines of Comparative Anatomy of Vertebrates. Central Book Depot, Allahabad.
20. Kent, C.G. Comparative Anatomy of Vertebrates.
21. Malcom Jollie, Chordata morphology. East-West Press Pvt. Ltd. New Delhi.
22. Milton Hilderbrand. Analysis of vertebrate structure. IV Ed. John Wiley and Sons Inc., New York.
23. Monielli, A.R. The chordates, Cambridge University Press, London.
24. Smith, H.S. Evolution of chordata structure. Hold rinehart and Winston Inc., New York.
25. Sedgwick, a.A. Students Text Book of Zoology, Vol. II.
26. Tansley, K. Vision in vertebrate. Chapman and Hall Ltd., London.
27. Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York and London.
28. Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.
29. Wolstenholmf, E.W. and Knight, J.(Ed). Taste and smell in vertebrates, J & A Churchill, London.
30. Romer, A.S., Vertebrate Body, IIIrd Ed. W.B. Saunders co., Philadelphia.
31. Young, J.Z. Life of vertebrates. The Oxford University Press, London.
32. Young, J.Z. Life of mammals, Oxford University Press, London.
33. Colbert, E.H. Evolution of the vertebrates, John Wiley and Sons Inc., New York.
34. Romer, A.S. Vertebrate Paleontology, 3rd Edn. University of Chicago Press, Chicago.
35. Clark, W.E. History of the Primates IV Edn. University of Chicago Press, Chicago.
36. Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Edn. McGraw Hill Book Co, New York.
37. Messers, H.M. An introduction of vertebrates anatomy.

- 38 Montagna, W. Comparative anatomy. Hohn. Wiley and Sons Inc.
 39 de Deer, S.G. Embryos and Ancestors. Clarendon Press, Oxford.
 40 Andrews, S.M. Problems in vertebrate evolution. Academic Press,
 New York.
 41 Waterman. A.J. chordata structure and function. Macmillan co.,
 New York.
 42 Bhamrah and Juneja, Chordate Zoology, Anmol Publishers, N.Delhi
 Bhamarah and Juneja, Invertebrate Zoology, Anmol Publishers,
 N.Delhi.
 43 Bhamarah and Juneja, Invertebrate Zoology, Anmol Publishers,
 N.Delhi.
 44 Barbiur, T. Reptiles and Amphibians: Their habits and adaptations.
 Hongton Miffin Co., New York.
 45 Kingsley Noble, g. The biology of the Amphibia. Dover
 Publications, New York.
 46 Smyth. Amphibia and their ways. The McMillan co., New York.
 47 Andrevos, S.M., Miles, r.S. and Walker, A.D. Problems in vertebrate
 evolution. Academic Press, New York.

Practical I (Based on paper I and II)

ANIMAL STRUCTURE AND FUNCTION (NON-CHORDATA AND CHORDATA)

A) Dissections:-

- 1) Nervous system:- Crab; Sepia/Loligo Squilla/Prawn, Earth worm
- 2) Digestive ,Reproductive Systems and Neck nerves of rat/ mouse
- 3) Digestive, Arterial systems and Cranial nerves of Scoliodon, Internal ear of Scoliodon.

B) **Mounting**:- Nephridium and spermatheca of Earthworm. Gill-lamella of Pila . Trachea of Cockroach, mouth parts of various insects (Honey bee, butterfly, mosquito , housefly etc.) and Booklungs of Scorpion. Ovary of Earth worm, Osphradium of Pila, Statocyst of Prawn, Velum of *Amphioxus*, Ampulla of Lorenzini from Scoliodon, fish scales.

C) Museum Study:-

- Protozoa:- *Gregarines, Monocystis, Ceratium, Euplotes, Didinium, Noctiluca, Radiolaria, Stenter, Opalina, Balantidium, Nyctotherus, Plasmodium.*
- Porifera:- Sycon , Grantia.
- Cnidaria:- Obelia polyp and medusa (whole mounts), Pennaria, Aurilaria Vergularia, Spongodus, Zoanthus, Favia.

- Helminthes :- Temnocphala (whole mount);. Ascaris lumbricoides, Taenia solium, Plannaria
- Annelida:- Ozobronchus, Glossiphonia (whole mounts);. Eunice, Cholea flava, Polynoe, Terebella, Eurythoe.
- Arthropoda :- Cyclops, Daphnia, Chelifer (whole mounts); Balanus, Lepas, Palinurus, Uca, Pycna, Belostoma, Limulus, Squilla, Eupagurus.
- Mollusca: Dollobdella, Pteria, Nerita, Sanguinolaria, Chicoreus, Ficus, Lambis, Tridacna, Onchidium, Olivia, Murex, Bulla, Cardium, Arca.
- Echinodermata :- Linckia, Echinodiscus, Holothuria, Antedon.
- Minor Phyla: Bigula, Plumatella, Cristatella, Pectinella (whole mounts) Phoronis, Dendrostoma.
- Larval Forms: Planula, Redia, Cercaria, Trochophore, Nauplius, Zoea, Mysis Phyllosoma, Antilon, Veliger, Bipinnaria, *Ophio* and Echinopluteus, Auricularia, Tornaria.
- Protochordates - Salpa-sexual, Salpa-asexual, Botryllus, Herdmania,
- Pisces- Rhinobatus, Chimaera, Acipenser, Amia, Periopthalmus, Triacanthus, Chimaera, Acipenser, Amia, Periopthalmus, Triacanthus, Notopterus notopterus, Scatophagus argus, Trichiurus, Mastacembalus armatus, Exocoetus , Diodon hystrix, Echineis neucrates.
- Amphibians- Ichthyophis, Geganophis, Rhacophorus, Rana tigrina, Amblystoma.
- Reptiles– Sitana, Chameleon, Phrynosoma, Chelone mydas.
- Birds – Indian Oriole, Indian koel (male, female), Indian tailor bird, kite, jungle fowl.
- Mammals – Indian Otter, Marmoset, Loris, Bat (*Megaderma lyra*), Pangolin.
 Skull and lower jaw from a species of amphibia, reptilia, bird, carnivore mammal , Herbivore mammal.
- Types of vertebrae — Procoelus, Opisthocoelus, Amphicoelous, Amphiplatian, Heterocoelus, Axis and atlas vertebrae, Study of endangered animals (from photographs).
- One long study tour, preferably at the sea-shore for study and observations of animals in their natural habitat is compulsory for the students.
- Candidates shall be required to produce at the practical examination the following.

1. Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the bonafide work of the candidate.
2. 20 permanent stained micro- preparations of animals: whole mounts or parts thereof, histological preparation prepared by the examinee himself.

Distribution of Marks for practical I

1) Major Dissection	—08 marks
2) Minor dissection	—06 marks
3) Identification and comments on spots	—08 marks
4) Stained permanent preparation	—05 marks
5) Submission of permanent preparation	—03 marks
6) Practical record	—05 marks
7) <i>Viva-voce</i>	—05 marks
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Total	—40 marks
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Internal Assessment	—10 marks
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Total	—50 marks

M.Sc. (Zoology)

Semester – I

PAPER – III MOLECULAR CELL BIOLOGY

Unit- I Biomembranes

- 1.1 Biochemical Composition of biomembranes
- 1.2 Transport across cell membrane & transporters.
- 1.3 Membrane potential
- 1.4 Transport across epithelia.

Cell Signalling

- 1.5 Signalling molecules & cell surface receptors
 1. Properties of cell surface receptors
 2. G- protein coupled with adenylyl cyclase ,
 3. G- protein coupled with ion channels ,
 4. G- protein coupled with phospholipases
- 1.6 Nonreceptor and receptor mediated signaling
- 1.7 Intracellular signal transduction
- 1.8 Activation of gene transcription by G – protein coupled receptors – JAK and STAT pathways

Unit - II Extracellular matrix

- 2.1 - Basement membrane, basal lamina structural components, cross linking components.
- 2.2 Collagens & other proteins of extracellular matrix.

- 2.3 Cell-cell adhesion molecules.
- 2.4 Cell-matrix adhesion.
- 2.5 Gap junctions & connexins

Unit III Cell cycle control

- 3.1 Cyclins & cyclin dependent kinases (CDK), Role of MPF
- 3.2 Replication block & its removal.
- 3.3 Checkpoints & feedback control.
- 3.4 Regulation of CDK-Cyclin Activity
- 3.5 Programmed cell death – Definition, mechanism & significance
- 3.6 Abnormal cell division

Unit IV Cytoskeleton & Mitochondrial Genome

- 4.1 Microfilaments & microtubules- structure and dynamics
- 4.2 Microfilaments membrane binding proteins & their function.
- 4.3 Intermediate filaments & their functions
- 4.4 Role of microtubules in mitosis.
- 4.5 Role of mitochondrial DNA in evolutionary biology
- 4.6 Mitochondrial DNA & ageing

Unit V Secretory pathway

- 5.1 Protein synthesis in eukaryotes
- 5.2 Uptake into ER
- 5.3 Co- & Post translational modifications in ER
- 5.4 Protein sorting in Golgi apparatus
- 5.5 Transport of proteins across nuclear membrane
- 5.6 Lysosomal assembly & functions

M.Sc.(Zoology) Semester I

Paper IV

TOOLS AND TECHNIQUES IN BIOLOGY

Unit I 1.0 Principles and uses of

- 1.1 Colorimeter
- 1.2 Spectrophotometer,
- 1.3 Spectrofluorometer,
- 1.4 Atomic absorption spectrophotometer,
- 1.5 ESR and NMR spectrometers,
- 1.6 XRD
- 1.7 Radioactivity counters,
- 1.8 Nanorobot & Nubot

Unit II 2.0 Principles and application of light, phase contrast, fluorescence, Scanning and transmission electron microscopy, Atomic Force microscopy

Microbiological techniques

- 2.1 Media preparation and sterilization.
- 2.2 Inoculation and growth monitoring.
- 2.3 Use of fermenters.
- 2.4 Biochemical mutants and their use.
- 2.5 Microbial assays.

- Unit III
- 3.1 Organelle separation by centrifugation
 - 3.2 Cell separation by density gradient centrifugation, unit gravity centrifugation, affinity adsorption, anchorage based techniques
 - 3.3 Cell culture techniques- Monolayer and Polylayer
 - 3.4 Design and functioning of tissue culture laboratory.
 - 3.5 Cell proliferation measurements.
 - 3.6 Cell viability testing.
 - 3.7 Culture media preparation and cell harvesting methods.
 - 3.8 Tissue engineering

- Unit IV
- 4.0 **Cryotechniques**
 - 4.1 Cryopreservation for cells, tissue, organisms.
 - 4.2 Cryotechniques for microscopy.
 - 4.3 Freeze-drying for physiologically active substances.
 - 4.4 Separation techniques in biology.
 - 4.5 Molecular separation by thin layer and gas chromatography, high pressure liquid chromatography, ion exchange and affinity chromatography, electrophoresis,

- Unit V
- 5.0 **Radioisotope and mass isotope techniques in biology.**
 - 5.1 Sample preparation for radioactive counting.
 - 5.2 Autoradiography.
 - 5.3 Metabolic labeling.
 - 5.4 Magnetic Resonance Imaging.
 - 5.5 Liquid scintillation spectrophotometry
 - 5.6 Radiation dosimetry
 - 5.7 Radioactive isotopes and half life of isotopes
 - 5.8 Cerenkov radiation
 - 5.9 Immunological techniques based on antigen-antibody interactions.

Selected Reading Material

1. Molecular cell Biology , J. Darnell , H. Lodish & D. Baltimore , Scientific American Book , Inc. USA.
2. Molecular cell Biology of the cell , B Alberts , D Bray , J. Lewis , M. Raff , K. Roberts and J. D. Watson . Garland Publishing Inc. New York.

3. The cell a molecular approach : Cooper
4. Molecular cell biology : Gerald Karp
5. Animal Cell Culture – A practical approach, Ed. John R.W.Masters. IRL Press.
6. Introduction to instrumental analysis, Robert Braun. McGraw Hill International Editions.
7. A Biologists Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.
8. Foundation in microbiology : Talaro
9. Microbiology : Pelczar
10. Biology of micro- organisms : Madigan, Martinko and Parker.
11. Biophysical chemistry- Principles and technique : Upadhyay, Nath

List of practical based on papers III and IV (Practical II)

1. Organelle separation by centrifugation
2. Electrophoretic separation of proteins
3. Light microscopic demonstration of Plasma membrane .(oil red O, Sudan black B)
4. Demonstration of mitochondria by vital staining.
5. Histochemical demonstration of extracellular matrix.(glycoproteins- Alcian blue pH 1,2.5, PAS)
6. Histochemical demonstration of Lysosomes by demonstrating acid phosphatase activity.
7. Histochemical demonstration of DNA & RNA by Feulgen & MGPY technique
8. Study of metaphase chromosomes in frog / rat bone marrow / tadpole tail tip .
9. Culturing of protozoans (Paramecium, Amoeba and Volvox)
10. Preparation of different cell types.
11. Comparison of RBC & WBC in different groups of vertebrates.
11. Media preparation for prokaryotic cell culture .
13. Different methods of sterilization (Dry, wet and UV sterilization)
14. *E.coli* culturing.
15. Gram staining of micro-organisms
16. Cell viability testing.
17. Design of tissue culture lab by modeling
18. Preparation of tissue sections & light microscopic examination.
19. Uses of different microscopes.
20. Absorption spectrum of any colored solution of a substance.
21. Separation of amino acids by paper chromatography.
22. Sub cellular fractionation of rat liver.

23. Determination of molecular weights of proteins by SDS-PAGE and densitometric scanning.

Candidates shall be required to produce at the practical examination, the following-

Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the bonafide work of the candidate.

Distribution of Marks for Practical – II

The practical shall be of 40 marks with a duration of 6 hours and distribution of marks will be done as below-

1.	Cytological / Histochemical preparation/microbiological Preparation	:	10marks
2.	Experiment –I	:	10marks
3.	Experiment –II (Chromatography / electrophoresis)	:	10 marks
4.	Class record	:	05 marks
5.	Viva-voce	:	05 marks
	Internal assessment:	:	10 maks

	Total	:	50 marks

M.Sc. (Zoology)

Semester II

PAPER-V : GAMETE BIOLOGY

Unit I

- 1.1 Heterogamy in eukaryotes.
- 1.2 Leydig cells
 - 1.2.1 Morphology
 - 1.2.2 Differentiation
 - 1.2.3 Functions and its regulation
- 1.3 Spermatogenesis
 - 1.3.1 Morphological basis
 - 1.3.2 Gamete specific gene expression
- 1.4 Biochemistry of Semen
 - 1.4.1 Formation of semen and its composition
 - 1.4.2 Assessment of sperm functions
- 1.5 Ovarian follicular growth and differentiation
 - 1.5.1 Morphology
 - 1.5.2 Endocrinology
 - 1.5.3 Molecular Biology

- 1.6 Oogenesis and vitellogenesis-morphogen gradient
 - 1.7 Ovulation
- Unit II
- 2.1 Fertilization
 - 2.2 Reaction of sperm (Sperm motility, Capacitation, acrosome reaction, Fusion of sperm and egg plasmalemma)
 - 2.3 Reaction of egg (formation of fertilization cone, Prevention of polyspermy)
 - 2.4 Amphimixis
- Unit III
- 3.1 Creating multicellularity
 - 3.2 Characteristics of cleavage divisions
 - 3.3 Cleavage types
 - 3.4 Gastrulation
- Unit IV
- 4.0 Assisted reproduction techniques
 - 4.1 In vitro fertilization
 - 4.2 Multiple ovulation/super ovulation
 - 4.3 Collection and cryopreservation of gametes
 - 4.4 In vitro gamete maturation
 - 4.5 In vitro fertilization
 - 4.6 Embryo sexing Y specific probes
 - 4.7 Screening of genetic disorders.
 - 4.8 ICSI and GIFT
 - 4.9 Cloning of animals by embryo transfer
- Unit V
- 5.0 Transgenic animals
 - 5.1 Procedure
 - 5.2 Applications
 - 6.0 Gene Knockout technology
 - 6.1 Procedure
 - 6.2 applications

M.Sc. II Semester II

Paper VI : GENES AND DIFFERENTIATION

Unit I

- 1.0 Cell specification
- 1.1 Types of Cell specification
- 1.2 Cell commitment and differentiation
- 1.3 Characteristics of Differentiation
- 1.4 Germ cell determinants (in nematodes, insects, amphibians)
- 1.5 Germ cell migration (in amphibians, reptiles, mammals and birds)
- 1.6 Organizers and evocators

Unit II

2.0 Body axis formation

- 2.1 Genetics of axes specification in *Drosophila*
- 2.2 Establishment of body axes in mammals and birds.
- 2.3 Proximate tissue interactions (instructive and permissive)
- 3.0 Homeobox concept in different phylogenetic groups

Unit III

- 3.1 Immunocontraception – gamete specific antigens, antibody mediated fertilization block and termination of gestation
- 3.2 Environmental evolution
 1. Environmental cues and effects
 2. Malformation and disruption – Teratogenic effects of xenobiotics
 3. Changing evolution through development modularity
 4. Developmental constraints.
 5. Creating new cell types –basic evolutionary mystery

Unit IV

- 4.1 Biology of sex determination
- 4.2 Chromosomal sex determination in mammals and *Drosophila*
- 4.3 Differentiation of gonads
- 4.4 Secondary sex determination in mammals
- 4.5 Environmental sex determination
- 4.6 Regeneration
- 4.7 Connective tissue cell family.

Unit V

5.0 Stem cells

- 5.1 Properties of stem cells
- 5.2 Types of stem cells – Embryonic , umbilical, adult.
- 5.3 Stem cell therapy
- 5.4 Stem cell disorders
- 5.5 Haemopoietic stem cells and Formation of blood cells
- 5.6 Bone marrow transplantation

PRACTICALS III (Practical based on Paper V and VI)**LIST OF PRACTICALS**

1. Morphology and histology of non-chordate and chordate ovary and testis (Insects snails frog and rats)
2. Oogenesis and spermatogenesis through gonad histological preparation
3. Study of different types of eggs on the basis of their yolk content
4. Collection of frog and toad spawn (rearing) embryos and larvae up to metamorphosis in the laboratory, preparation and study of stages of development

5. Study of cleavages in limnea in laboratory.
6. Mounting of larvae in Limnea
7. Study of development of *Amphioxus*, Frog, Chick and pig through slides and whole mounts
8. Effect of antifertility drugs on biochemical estimation in various part of reproductive tract
 1. Ascorbic acid
 2. Acid/Alkaline phosphatase
9. Induced cell death during development in garden lizard/ amphibia/ Chick.
10. Morphogenesis and growth study of chick development
11. Sperm count
12. Study of abnormal sperm count
13. Semen analysis
14. Study of different types of cells present in bone marrow
15. Effects of different drugs on pregnant rats
 1. Amoxicillin
 2. diclophenac sodium
 3. paracetamol
 4. Penicillin
 5. Ibuprofen

The examinee shall be required to produce at the practical examination the following :

Practical record book duly signed by teacher in charge and certified by the Head of the Department as a bonafide work of the examinees.

Distribution of Marks

The practical shall be of 50 marks of six hours duration & distribution of marks will be as follows:

- | | |
|---|------------|
| 1. Mounting of Chick embryo /any molluscan larvae | :10marks |
| 2. Identification of spots | :10marks |
| 3. Estimation / histological preparation/semen examination slide of bone marrow | :10marks |
| 4. Practical record | : 05 marks |
| 5. <i>Viva voce</i> | : 05 marks |

Total	40 marks
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Internal assessment

	10marks
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Total	50 marks
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PAPER VII – ENDOCRINOLOGY

Marks : 50

Unit –I

- 1.1 Histology of vertebrate endocrine glands : Pituitary gland, Thyroid gland, Parathyroid gland, Adrenal gland , Pineal and Thymus gland
- 1.2 Histology of endocrine placenta, testis and ovary in vertebrates
- 1.3 Structure and functions of Islets of Langerhans
- 1.4 Histology of Urophypophysis and Corpuscles of Staninus in fishes

Unit - II

- 2.1 Classification of Hormones (Peptide and Steroid)
- 2.2 Hormonal action at cellular level
- 2.3 Hormone action at genetic level
- 2.4 Hormones in biological clock
- 2.5 Metabolic and developmental hormones
- 2.6 Hormonal regulation of carbohydrate, Lipid and Protein metabolism
- 2.7 Hormonal regulation of Growth and Reproduction

Unit- III

- 3.1 Synthesis, transport (release) and metabolism of steroid hormones
- 3.2 Synthesis, transport and metabolism of T₃, T₄ and epinephrine
- 3.3 Synthesis transport and metabolism of insulin hormone
- 3.4 Hormones & Behavior
- 3.5 Prostaglandins
- 3.6 Ectohormones in insects and mammals

Unit -IV

- 4.1 Thyroid disorders
- 4.2 Parathyroid disorders
- 4.3 Pituitary Disorders
- 4.4 Adrenal Gland Disorders
- 4.5 Diabetes: Diabetes Type I , Diabetes Type II, Diabetic Kidney Problems, Diabetes and Pregnancy, Diabetic Nerve Problems, Autoimmune diabetes
- 4.6 Comparative study of steroid and non-steroid hormones in reproduction

Unit –V

- 5.1 Hormone replacement therapy
- 5.2 Risks and benefits of Hormone replacement therapy
- 5.3 Other hormones: Renin, angiotensin, ctokines, ANF, Erythropoietin
- 5.4 Evolution of hormones
- 5.5 Neuroendocrine mechanism in insects and crustacean metamorphosis
- 5.6 Neuroendocrine mechanism in Amphibian metamorphosis

M.Sc. : Zoology

Semester – II

PAPER VIII – ECOLOGY AND ENVIRONMENT

- Unit-I :** **The Environment:** Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
- Population Ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
- Species Interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
- Unit-II :** **Community Ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- Ecological Succession:** Types; mechanisms; changes involved in succession; concept of climax.
- Ecosystem Ecology:** Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).
- Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
- Unit-III :** **Applied Ecology:** Environmental pollution; global environmental change; Global warming; biodiversity status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
- Conservation Biology:** Principles of conservation, major approaches to management, Indian case studies on

conservation/management strategy (Project Tiger, Biosphere reserves). Importance of Buffer and corridor for the conservation of Sanctuaries and different wildlife projects.

Bioresource and uses of biodiversity: Plant bioresources, Animal bioresources; Microbial bioresources

Bioremediation and phytoremediation

Unit-IV : Environmental Monitoring:

IGPCC (Inter Government Policy/ Protocol for Climate change)

EPA (Environmental Protection Agency) Laws, legislation pertaining to environment Control, monitoring & surveillance of environment.

NTCA and Functions of National Tiger Conservation Authority

IPR (Intellectual Property Rights) – Patents [need , how to obtain in India & abroad, Patent offices in India.]

Environmental Impact Assessment: Impact of Dams and Reservoir; Impact of Coal mines; Impact of Thermal power Stations; Impact of Industrialization

Unit-V : Stress Physiology and Toxicology

Stress Physiology:

Basic concepts of environmental stress & strain

Stress resistance, stress avoidance & stress tolerance

Concept & physiological mechanism of regulation of body temperature.

Physiological adaptation to osmotic and ionic stress.

Physiological response to oxygen deficient stress.

Physiological response to body exercise.

Toxicology:

Metabolism & effects of organochlorine, organophosphate and carbamate pesticides

Metabolism & effects of alkaloids, barbiturates, alcohol & cyanides.

Metabolism & effects of heavy metal salts.

Formation & effects of free radicals.

Biochemistry of Detoxification – Phase I & phase II reactions.

List of books :

1. Toxicology - A Sood , Sarup & Sons, New Delhi.
2. Biodegradation of pesticides - G. N. Vankhede , Bajaj Publication

3. Environmental biodegradation, Ramkumar, Sarup & Sons , New Delhi

4. Toxicology by Parikh.

5. Poisoning by drugs & chemicals - Cooper

6. Analytical toxicology of inorganic poisons - Jacob M.B

7. Environmental management of toxic and hazardous chemical -Madhuraj

8. Environmental Biology - J. L. Blish

9. Fundamental Ecology - Odum

Practical:

1. ELISA for any hormone

2. To study the rate of oxygen consumption by aquatic animals under various environmental stress.

3. Histology of various endocrine glands

4. Effect of toxicants on histoarchitecture of various endocrine glands

5. To study changes of blood glucose level under various environmental stress

6. Determination of respiratory quotient of an air breathing animal at different temperatures.

7. To study the changes of blood glucose level under various environmental stresses in a vertebrate species

8. Study of toxicity of given chemical to analyze its activity histologically

9. Study of toxicity of given chemical on various blood and tissue biochemicals.

10. To estimate total hardness of different samples of water.

11. To estimate nitrate contents from different samples of water.

Candidates shall be required to produce at the practical examination, the following-

Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the bonafide work of the candidate

Distribution of Marks

Total Marks : 50

The practical shall be of 50 marks of six hours duration and distribution of marks will be as follows:

1. Histological preparation 10 marks

2. Experiment I (estimation) 10 marks

3. Experiment II (estimation) 10 marks

4. Class record 05 marks

5 *viva voce* 05 marks

Internal Assessment 10 marks

Total : 50 marks

Unit – I

1.0 Mutation :

- 1.1 The molecular basis of gene mutation: mutations induced by chemicals, radiation and transposable genetic elements
- 1.2 Mutations caused by the DNA replication machinery
- 1.3 Hot spots of mutation
- 1.4 Detection of mutagens
- 1.5 DNA repair mechanisms, the error-prone repair system

Unit – II

2.0 Somatic Cell Genetics:

- 2.1 Cell fusion and hybrids – agents and mechanism of fusion
- 2.2 Heterokaryon – selecting hybrids and chromosome segregation
- 2.3 Radiation hybrid panels and gene mapping

Unit III

3.0 Genome Organization

- 3.1 Hierarchy in genome organization
- 3.2 Mobile DNA

Molecular Basis of Cancer

- 3.3 Molecular biology of cancer
- 3.4 Oncogenes
- 3.5 Tumor Suppressor genes

Unit IV

4.0 Human Cytogenetics

- 4.1 **Numerical abnormalities of human chromosomes and related syndromes :**
Nondisjunction, Aneuploidy, Patau syndrome, Edwards syndrome, Down syndrome, Turner syndrome, Klinefelter syndrome
- 4.2 **Structural abnormalities of human chromosomes and related syndromes :**
Deletion, Robertsonian translocation, Cri-du-chat syndrome, Prader-Willi syndrome, Williams syndrome, Wolf-Hirschhorn syndrome
- 4.3 **Human metabolic disorders:**
Phenylketonuria, Lesch-Nyhan syndrome, Tay-Sachs disease, Alkaptonuria, Albinism, Congenital adrenal hyperplasia, Emphysema, Glucose-6-phosphate dehydrogenase deficiency

Unit V

- 5.1 Mitochondrial DNA and human diseases
- 5.2 **Genetic Counseling :** Carrier detection, Fetal analysis (amniocentesis and chorionic villus sampling)
- 5.3 Gene therapy

Unit I

1.0 Drosophila Genetics:

- 1.1 Introduction to *Drosophila* genetics, advantages
- 1.2 **Polytene chromosomes :** Polytenisation process, significance, bands, interbands, puffs, regulation of puffing activity, ecdysone puffs, induction of puffs by stress
- 1.3 **Behavioral and Neurogenetics :** Behavioural traits, mutants, tools and methodologies for genetic analysis, genetic and molecular basis of behavioural traits in *Drosophila*

Unit II

2.0 Microbial genetics :

- 2.1 Bacterial transformation, transduction and conjugation, Bacterial chromosome
- 2.2 **Bacteriophages :** Types, structure and morphology of T4 phage, morphogenesis

Unit III

3.0 Molecular Cytogenetic Techniques :

- 3.1 DNA fingerprinting
- 3.2 Flow cytometry
- 3.3 Automated karyotyping
- 3.4 Chromosome painting
- 3.5 DNA sequencing

Genome Analysis :

- 3.6 Detailed account of genome models of lambda phage, *E. Coli*, *C. elegans*, *Drosophila* and Human.
- 3.7 Functional genomics

Unit IV

4.0 Population Genetics :

- 4.1 Genetic variation in natural populations, Phenotypic variation, Polymorphism of chromosome structure
- 4.2 Hardy-Weinberg principle of genetic equilibrium, Genetic drift, Gene pool
- 4.3 Ecological significance of molecular variations

4.4 Conservation of genetic resources in diverse taxa

Genetics of quantitative traits in populations :

4.5 Molecular analysis of quantitative traits

4.6 Genotype – environmental interactions

4.7 Inbreeding depression and heterosis

Unit V

5.0 Molecular Phylogenetics :

5.1 How to construct phylogenetic trees

5.2 Nucleic acid phylogeny – DNA-DNA hybridization, Restriction enzyme sites, nucleotide sequence comparisons and homologies

5.3 Protein phylogeny

5.4 Molecular clocks

5.5 Tools of phylogeny

Practicals for Paper – IX and X (Molecular Cytogenetics)

(PRACTICAL V)

- 1) Demonstration of Barr bodies in leucocytes of human female
- 2) Demonstration of salivary gland chromosomes from *Chironomous / Drosophila* larvae
- 3) Study of mitosis in cleaving eggs from Frog / any invertebrate
- 4) Study of meiosis from Grasshopper / Rat testes using smear method
- 5) Histological demonstration of meiosis in Rat testis
- 6) Preparation of human karyotype by using photograph/picture
- 7) Culture of *Drosophila* and study of life cycle and sexual polymorphism
- 8) Identification of wing and eye mutants in *Drosophila*
- 9) Extraction of DNA
- 10) Estimation of DNA (spectrophotometric)
- 11) Extraction of RNA
- 12) Estimation of RNA (spectrophotometric)
- 13) Problems on Genetics based on dihybrid crosses, sex-linked inheritance and blood groups
- 14) Study of various human genetic traits

The examinee shall be required to produce at the practical examination the following :

1. Practical record book duly signed by teacher in charge and certified by the Head of the Department as a bonafide work of the examinees.

Distribution of Marks :

The practical shall be of 50 marks of six hours duration & distribution of marks will be as follows :

1. Estimation/Experiment	:	15 marks
2. Cytological Preparation	:	07 marks
3. Problems on Genetics (any two)	:	08 marks
4. Class Record	:	05 marks
5. <i>Viva Voce</i>	:	05 marks

Total	:	40 marks
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Internal Assessment

10 marks

Total	:	50 marks
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Suggested Readings :-

1. Atherly, A.G., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, NY.
2. Brooker, R.J. Genetics: Analysis and Principles, Benjamin/Cummings, Longman
3. Fairbanks, D.J. and W.R. Anderson. Genetics – The continuity of Life. Brooks/Cole Publishing Company ITP, NY, Toronto.
4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley and Sons, Inc. NY.
5. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. An Introduction to genetic analysis. W.H. Freeman and Company, New York.
6. Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo.
7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley & Sons.
8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steiz and A.M. Weiner, Molecular Biology of Genes. The Benjamin/Cummings Pub. Co. Inc. Tokyo
9. Mange E.J. and A.P. Mange. Basic Human Genetics 2nd edn. Sinauer Associates
10. Russel P.J. Genetics 5th edn. The Benjamin/Cummings Pub. Co.
11. Vogel, F. and A.G. Motulsky. Human Genetics . 2nd edn. Springer-Verlog, NY
12. Hartl. D.L. and E. W. Jones: Genetics-Principles and analysis. 4th edn. Jones & Bartlett Pub. Boston

13. Weaver R.F. & P.W.Hedrick : Genetics 3rd edn. Wm.C.Brown Pub.London

M.Sc.(Zoology) Semester III: Paper-XI

MOLECULAR BIOLOGY – I (Elective paper I)

Unit- I **1.0 Scope of Molecular Biology**

1.1 DNA replication :

1. Mechanism of DNA replication
2. Prokaryotic DNA replication
3. Eukaryotic DNA replication

Unit- II

2.0 Prokaryotic transcription

2.1 Prokaryotic transcription initiation

1. Binding of RNAP to the promoter
2. Isomerization : conversion of closed complex into open complex
3. Phosphodiester bond formation and abortive initiation
4. Promoter clearance (promoter exit, promoter escape)

2.2 Prokaryotic transcription elongation

1. Transcription bubble
2. Positive and negative supercoiling
3. Change in shape of RNA polymerase
4. Movement of RNAP during transcription
5. Transcription elongation complex and RNA chain elongation
6. Difference between transcription and DNA replication

2.3 Prokaryotic transcription termination

1. Terminators
2. Antitermination
3. Attenuation

Unit - III

3.0 Eukaryotic transcription

3.1 Eukaryotic transcription initiation

3.2 A. RNAP I System

1. RNAP I promoters
2. RNAP I transaction factors
3. RNAP I transcription initiation

B. RNAP II System

1. RNA polymerase II (RNAP II)
2. RNAP II promoters of protein coding genes
3. RNAP II initiation factors of protein coding genes

4. RNAP II transcription initiation of protein coding genes
5. RNAP II transcription initiation of snRNA genes
6. Role of RNA polymerase II in mRNA processing

C. RNAP III SYSTEM

1. Transcription of tRNA genes
2. Transcription of 5S rRNA genes
3. Transcription of U6 snRNA genes

3.2 Eukaryotic transcription elongation

RNA polymerase II and elongation cofactors

3.3 Eukaryotic transcription termination

1. RNAP I (Pol I) termination
2. RNAP II (Pol II) terminators
3. RNAP III (Pol III) termination

Unit - IV

4.0 Regulation of transcription

4.1 Prokaryotic transcription regulation –Lac, Trp and Ara operons

1. Negative regulation : repression
2. Positive control: activation
3. Dual control
4. Stringent control
5. DNA supercoiling
6. DNA methylation
7. RNA polymerase modification
8. Antitermination
9. Attenuation

4.2 Eukaryotic transcription regulation

1. Regulatory elements of RNAP II
2. Regulatory proteins

A. POSITIVE TRANSCRIPTION REGULATION IN EUKARYOTES

1. Activator function by removal of chromatin-mediated repression
2. Activator function by stimulation of the basal transcription apparatus
3. Role of activators in transcription initiation
4. Transcriptional coactivator complexes

B. NEGATIVE TRANSCRIPTION REGULATION IN EUKARYOTES.

1. Repressers interfering with transcriptional activators
2. Assembly of the general transcription machinery

Unit -V

5.0 Post-transcriptional modifications in RNA :

- 5.1 5' cap formation
- 5.2 Transcription termination
- 5.3 3' - end processing and polyadenylation
- 5.4 Splicing and Editing
- 5.5 Nuclear export of mRNA
- 5.6 mRNA stability

6.0 Translation :

- 6.1 Genetic code
- 6.2 Prokaryotic translation and Eukaryotic translation
- 6.3 The translational machinery
- 6.4 Polyribosome formation
- 6.5 Mechanisms of initiation, elongation and termination
- 6.6 Regulation of translation

Semester III: Paper- XII

MOLECULAR BIOLOGY – II (Elective paper-II)

Unit I

1.0 Molecular mapping of genome :

- 1.1 Genetic and physical maps
- 1.2 Physical mapping and map-based cloning
- 1.3 Choice of mapping population, simple sequence repeat loci
- 1.4 Southern and fluorescence *in situ* hybridization for genome Analysis
- 1.5 Chromosome microdissection and microcloning

Unit II

- 2.0 Molecular markers in genome analysis : RFLP, RAPD and AFLP analysis
- 2.1 Molecular markers linked to disease resistance genes
- 2.2 Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree analysis
- 2.3 Animal trafficking and poaching, germplasm maintenance and taxonomy

Unit III

3.0 Recombinant DNA Technology :

- 3.1 Restriction endonucleases and other enzymes used in RDT.

- 3.2 Vectors : Plasmids, Bacteriophages, Cosmids, Phagemids, m13, YAC's, BACs, MACs, shuttle vectors, expression vectors.

- 3.3 Cloning: Transformation , Transfection and Transgenesis
- 3.4 Genomic and cDNA library, oligonucleotide probe

Unit IV

- 4.0 Selection of transformants using antibiotic resistant genes, genetic markers, and hybridization, probe preparation - radioactive and nonradioactive probes, strategies used in hybridization -colony , plaque, northern and western blots, dot blot and slot blot hybridization, Western blotting

Unit V

- 5.0 Applications of genetic engineering in agriculture, Pharmacy, medicine, gene therapy, industries, environmental pollution.
- 6.0 PCR - principles, methodology, modifications, applications.

Selected Readings :

1. Kourilsky, P. "*Genetics - the thread of life*". Wiley Eastern Ltd. New Delhi
2. Newton, C. R. & A. Graham. *PCR 2/ed.* Bios Scientific Publishers
3. Fanning, E. , R. Knippers & E.L. Winnacker. "*DNA Rplication and The Cell Cycle*". Springer – Verlag, New York
4. Resnekov, O. & A.V. Gabain (Editors) "*Post – Transcriptional Control of Gene Expression*" Springer – Verlag, New York
5. Singer, M. & P. Berg (editors) "*Exploring Genetic Mechanisms*". University Science Books ,California
5. Williamson, R. (editor). "*Genetic Engineering - 2*", Academic Press, Inc. London.
6. Lodish *et al. Molecular Cell Biology*
7. Powar C..*B.Genetics Vol.I & Vol. II, Himalaya Publication*
8. Benjamin Lewin.*Gene VIII, Oxford Press*
9. McWright & Yamamoto.*Transcriptional regulation, Cold Spring Harbor Pub.*

Practical For paper XI and XII (Molecular Biology – I & II)

Practical III

1. Extraction of genomic DNA from plant leaves
2. Extraction of DNA from bacteria
3. Extraction of DNA from yeast
4. Extraction of DNA from tissue
5. Extraction of DNA from whole blood
6. Isolation of histones from DNA

7. Estimation of histone proteins.
8. Determination of molecular size of DNA
9. Restriction digestion
10. Determination of molecular weights of different DNA fragments by running a standard marker on agarose gel Electrophoresis
11. Demonstration of plasmids in the gel by gel electrophoresis
12. Isolation and cleaning the DNA fragment of interest from the agarose gel
13. DNA transformation into bacterial cells
14. Separation of immunological proteins (alpha,beta,gamma) by paper or gel electrophoresis
15. Estimation of total proteins

The examinee shall be required to produce at the practical examination the following :

Practical record book duly signed by teacher in charge and certified by the Head of the Department as a bonafide work of the examinees.

Distribution of Marks

The practical shall be of 40 marks of six hours duration & distribution of marks will be as follows . In addition to this there is internal assessment of 10 marks.

1. DNA Electrophoresis based experiment	:	10 marks
2. DNA Extraction based experiment	:	10 marks
3. Histones / Protein based experiment	:	10 marks
4. <i>Viva voce</i>	:	05marks
5. Certified Practical record book	:	05 marks

Internal assessment	:	10 marks
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Total	:	50 marks
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M.Sc.Zoology. Semester-III

Paper-XI

Special Group; Entomology: Paper I

Insect Classification and Morphology

Unit I:

1. Modern scheme of classification.
2. General characters of various orders.
3. General characters and Classification of Thysanura, Collembola.
4. General characters and Classification of: Odonata
5. General characters and Classification of Dictyoptera, Orthoptera,

Unit II:

1. General characters and Classification of Mallophaga, Siphunculata, Hemiptera,.
2. General characters and Classification of. , Coleoptera...
3. General characters and Classification of Siphonoptera, Diptera.
4. General characters and Classification of Lepidoptera, Hymenoptera.

Unit III :

1. Integument: Structure, composition and functions.
2. Structure of Head and antenna.
3. Mouthparts; Chewing, rasping sucking, sponging, and siphoning types of mouthparts.
4. Mechanism of feeding

Unit IV:

1. Structure of thorax: Thoracic segmentation and skeleton, Legs: structure and functions.
2. Wings: Structure, modification.
3. Coupling apparatus.
4. Principles of aerodynamics and mechanism of flight.

Unit.V:

1. Structure of abdomen: Segmentation and skeleton,
2. Abdominal appendages; pre and post genital appendages
3. Male external genitalia.
4. Female external genitalia.

M.Sc. Zoology. Semester-III

Paper-XII

Special Group Entomology: Paper II

Insect Anatomy, Physiology and Development

Unit I:

1. Digestive system : Structural organization of alimentary canal and Associated glands,
2. Physiology of digestion
3. Respiratory system; structural organization of terrestrial and aquatic respiratory organs.
4. Physiology of respiration

Unit.II:

1. Circulatory system: structural organization, composition of haemolymph, haemocytes.
2. Physiology of circulation.

- Unit III:
3. Excretory system: Structural organization of excretory organs.
 4. Physiology of excretion. and osmoregulation.
- Unit III:
1. Nervous system: Structural organization and physiology.
 2. Brain, learning and neurotransmitters.
 3. Female reproductive system: Structural organization and vitellogenesis.
 4. Male reproductive system: Structural organization, spermatogenesis and spermatophore formation.
- Unit IV:
1. Sensory organs: Mechano Sensory hairs, campaniform sensilla, chordotonal organs and multipolar stretch receptors, Auditory organs –Tympanal organs, auditory hairs, Johnston’s organ pilifer.: chemoreceptors- Sensilla trichoidea, Sensilla basiconica and styloconica, Sensilla coeloconica sensilla placodea., A typical sinsilla,
 2. Olfactory senses, gustatory senses, ocelli and eyes.
 3. Sound production: organs and mechanism of sound production by tapping of body parts, by frictional mechanism and by vibrating mechanism.
 4. Bioluminescence : Organs, mechanism and significance of light production.
- Unit V:
1. Early embryonic development: Types of eggs, Cleavage and blastoderm formation.
 2. Post embryonic development, types of metamorphosis, Types of larvae and pupae.
 3. Adult emergence: Nature, timing and control.
 4. Mechanism of moulting and sclerotization.

M.Sc.Zoology. Semester.III

Practical –VI

SPECIAL GROUP-ENTOMOLOGY-I

1. Insect collection : Preservation , identification, classification and characters unto families belonging to orders-odonata, orthoptera, Dictyoptera, Hemiptera, Lepidoptera, Coleoptera, Hymenoptera, Diptera, Siphunculata, Thysanura, etc.
2. Dissections of various organs and systems in Cockroach, grass hopper, Cricket, Mole cricket, Red cotton bug, honeybee, beetles, housefly, butterfly/ moth and caterpillars (silkworms).

3. Permanent stained micro preparations: Alimentary canal, salivary glands, gastric caecae, Malpighian tubules, testis, ovary, accessory sex glands, exocrine glands, endocrine glands, brain and other ganglia.
4. Permanent stained whole mount preparations: small size insects, larvae, pupal appendages, proventricular teeth, antennae, legs, wings.
5. Physiological Experiments:
 - Differential and total haemocytes counts.
 - Qualitative survey of digestive enzymes in salivary glands.
 - Qualitative survey of digestive enzymes in gut.
 - Estimation of total proteins/carbohydrates/lipids in haemolymph/tissues.
 - Detection of uric acid as end product of excretion in terrestrial insects.
 - Chromatographic analysis of haemolymph, amino acids.
 - Separation of haemolymph proteins by electrophoresis.
 - Estimation of Na⁺ & K⁺ in haemolymph by flame photometer.
 - Estimation of DNA and RNA in Haemocytes/tissues.
6. Visits to agricultural fields, national parks and forests for collection and observations of insects are compulsory. Student should collect local insects and submit at the time of examination, 10 morphological and 10 histological slide preparations should also be submitted.

Note:

Scheme of Examination

Practical – VI

Special Group- Entomology-I

Distribution of Marks	Full Marks: 50
1. Dissection	10
2. Physiological experiment	10
3. Permanent stained preparation	05
4. Identification of Morphological & Histological spots.(1-05)	05
5. Practical Record and Insect Collection	05
6. <i>Viva Voce</i>	05
Internal assessments	10

Total : 50

M. Sc. (Zoology) Semester – III**Paper – XI****LIMNOLOGY AND ECOTOXICOLOGY - I**

- Unit I **Aquatic Ecosystem**
 1.1 Concept and Components of Ecosystem
 1.2 Aquatic ecosystem-, River, Pond, Reservoir, Lakes, and Sea
 1.3 Brackish water ecosystem
 1.4 Ecological Pyramids
- Unit II **Limnological Parameters**
 2.1 Physical parameters and their role
 2.1.1 Temperature,
 2.1.2 Turbidity,
 2.1.3 pH
 2.1.4 Total Dissolved Solids (TDS)
 2.2 Chemical parameters and their role
 2.2.1 Dissolved Oxygen,
 2.2.2 Free Carbon Dioxide,
- Unit III **Chemical parameters and their role**
 3.1 Hardness,
 3.2 Alkalinity,
 3.3 Sulphates,
 3.4 Phosphates,
 3.5 Nitrates,
 3.6 Nitrites,
 3.7 Silicates,
 3.8 Arsenic,
 3.9 Fluorides etc.
- Unit IV **Water Pollution – Sources, Hazards and Control measures.**
 4.1 Domestic Sewage
 4.2 Agricultural wastes
 4.3 Industrial Effluents
- Unit V **Biodegradation**
 5.1 Biodegradation of Agricultural pesticides
 5.2 Biodegradation of Halogenated solvents
 5.3 Detoxification phenomenon and bioenzymes
 5.4 Bacteria and biodegradation.

M. Sc. (Zoology) Semester – III**Paper – XII****(ICHTHYOLOGY, AQUACULTURE AND FISHERIES – I)**

- Unit I **Classification of fishes**

General characters of –

- 1.1 Elasmobranch,
 - 1.2 Ostracoderms,
 - 1.3 Placoderms,
 - 1.4 Holocephali,
 - 1.5 Dipnoi and
 - 1.6 Crossopterygii
- Unit II **Respiration**
 2.1 Organs of Respiration in Fishes
 2.2 Types and structures of gills
 2.3 Accessory respiratory organs
 2.4 Mechanism of respiration
- Unit III **Culture Fishery**
 3.1 Biology of Indian major carps- Rohu, Catla and Mrigala
 3.2 Biology of Exotic carps- Common carp, Silver carp and Grass carp
 3.3 Collection of fish seeds from natural resources
 3.4 Hypophysation- Induced breeding techniques
 3.5 Bundh breeding- Dry and Wet bundh
 3.6 Transportation of fish seed and live fish
- Unit IV **Fundamentals of nutrition in aquaculture**
 4.1 Food and feeding habits of cultivable fishes
 4.1.1 Nutritional requirements of fishes
 4.1.2 Formulated feed and diet processing and management of feeding
 4.2 Fish diseases
 4.2.1 Infectious diseases- Parasitic, Bacterial, Viral and Fungal
 4.2.2 Noninfectious diseases- Nutritional and Stress
- Unit V **Principle and types of Fisheries of India**
 5.1 Inland Fisheries
 5.1 Riverine fisheries
 5.1 Reservoir fisheries
 5.1 Pond fisheries
 5.1 Marine fisheries
 5.1 Sardine fishery
 5.1 Mackerel fishery
 5.1 Bombay duck fishery

PRACTICAL-VI
SPECIAL GROUP : FISHERIES
M. Sc. (Zoology) Semester – III

Practical VI**Limnology and Ecotoxicology**

Water Analysis

1. Estimation of Dissolved gases
 - 1.1 Dissolved Oxygen
 - 1.2 Free Carbon dioxide
2. Estimation of Dissolved Solids
 - 2.1 Chlorides
 - 2.2 Carbonate, Bicarbonate and Total Alkalinity
 - 2.3 Total hardness
3. Estimation of nutrients
 - 3.1 Nitrites
 - 3.2 Nitrates
 - 3.3 Ammonia
 - 3.4 Phosphates
4. Estimation of Biological Oxygen Demand
5. Estimation of Chemical Oxygen Demand
6. Estimation of Primary productivity of any local pond, river, lake or reservoir.
7. Collection, preservation and estimation of planktons
 - 7.1 Qualitative analysis- Drawings with Camera lucida, Measurements with ocular micrometer scale, Identification, and classification
 - 7.2 Quantitative analysis- Enumeration of Zooplanktons by i) drop count method ii) Sedwick Rafter Cell method./ Preparation of Diversity index, Population density, Determination of dominance of the species.

Ichthyology, Aquaculture and Fisheries – I

1. Collection, identification and classification of economically important prawns, lobsters and mollusks.
2. Collection and Identification of common aquatic insects.
3. Permanent micro preparation of –
 - a different kinds of scales in fishes.
 - b. Intestinal fish parasites- Protozoan and Helminthes
4. Dissection of locally available fishes:
 - 4.1 Accessory respiratory organs in *Clarias* and *Heteropneustes*
 - 4.2 Swim bladder in *Labeo*
 - 4.3 Cranial nerves

Candidate shall be required to produce at the practical examination, the following:

1. Practical record book duly signed by the teacher in-charge and certified by the Head of the Department as the bonafide work of the candidate.
2. At least five slides of planktons.
3. Collection of at least 5 locally available Prawns, Lobsters, Molluscs.
4. Slides of the permanent micro preparations of the Scales

Distribution of Marks for Practical –VI

The practical will be of 40 marks of which marks will be allotted for –

- | | |
|---|----|
| a. Experiment_____ | 10 |
| b. Identification_____ | 05 |
| c. Dissection of locally available fish_____ | 10 |
| d. Qualitative analysis of Zooplanktons/Enumeration of zooplanktons from given sample/calculation of Population density/_____ | 05 |
| e. Record book_____ | 05 |
| f. <i>Viva voce</i> _____ | 05 |
| Internal assessment..... | 10 |

Total : 50 marks

M.Sc. Semester : III**Elective: BIOINFORMATICS****Paper-XI Introduction to Information Technology and Bioinformatics****Unit-I: Fundamentals of Bioinformatics**

- 1.1 Bioinformatics definition and Pharmaceutical industries.
- 1.2 Internet & Bioinformatics
- 1.3 Problems & opportunities in Bioinformatics.
- 1.4 Human genome project & Bioinformatics
- 1.5 Knowledge discovery & data mining

Unit-II: Basic Biostatistics

- 2.1 Introduction to biostatistics & data presentation.
- 2.2 Fundamental of Probability, sampling & estimation.
- 2.3 Hypothesis testing
- 2.4 Analysis of variance
- 2.5 Regression analysis

Unit-III : Fundamentals of computer

- 3.1 Fundamentals of computer
- 3.2 Introduction to DOS & Windows
- 3.3 Internet
- 3.4 MS Office (MS word, Powerpoint, Excel)
- 3.5 Programming language C.

Unit-IV : Basics of Biochemistry & Genetics

- 4.1 Introduction to carbohydrates ,proteins and lipids.
- 4.2 Enzymes, Nucleic acids & inborn errors of metabolism.
- 4.3 Genetical terminology & Symbolism
- 4.4 Mendel's laws, multiple allelism, Linkage & Crossing over.
- 4.5 Gene regulation and Gene mutation

Unit-V : Basic Immunology

- 5.1 Introduction to immune system
- 5.2 Animal cell culture & immnobiotehnology
- 5.3 MHC, Hybridoma & Genetically modified vaccines.
- 5.4 Immune response to infectious diseases (AIDS, Tuberculosis)
- 5.5 Interleukins and interferons

M.Sc. Zoology Semester : III**Elective : Bioinformatics-II****Paper-XII : Basic Bioinformatics****Unit-I : Basic Biology**

- 1.1 Molecular Systematic
- 1.2 Different forms of DNA
- 1.3 Forces stabilizing biomolecules
- 1.4 Mega-biodiversity hot spots
- 1.5 Molecular ecology

Unit-II : State of the art tools and technique

- 2.1 FAFLP,
- 2.2 Microarray
- 2.3 Automated DNA Sequencing
- 2.4 Real time PCR
- 2.5 RNAi (RNA interference)

Unit-III : Introduction to programming languages and Biological databases

- 3.1 Fundamentals of HTML
- 3.2 Introduction to SQL
- 3.3.Database types & management systems
- 3.4 Biological databases and their functioning
- 3.5 Introduction to Perl

Unit-IV : Sequence retrieval and alignment

- 4.1 BLAST and SRS system
- 4.2 Multiple sequence alignment using Dot matrix method
- 4.3 Needleman-Wunsch algorithms
- 4.4 Smith-Waterman algorithms
- 4.5 Use of scoring matrix and gap penalties in alignment.

Unit-V : Computational Biology

- 5.1 Data mining & sequence analysis
- 5.2 Submission of DNA & protein sequence to Databases.
- 5.3 Disease mapping
- 5.4 UTR identification
- 5.5 Pathway elucidation

The practical : VI (Bioinformatics)

1. DOS and Windows operating system
2. MS Office (MS word,Excel and Powerpoint)
3. C language
4. Practical based on HTML,
- 5.Statistical packages (SPSS, GeneStat and others)
6. Bioinformatics packages (Chroma, Peptool, PAUP,RasMol, Deepview, and Sequin)

The examinee shall be required to produce at the practical examination the following :

Practical record book duly signed by teacher in charge and certified by the Head of the Department as a bonafide work of the examinees.

Distribution of Marks

The practical shall be of 40 marks of six hours duration & distribution of marks will be as follows . In addition to this there is internal assessment of 10 marks.

- | | | |
|--|---|----------|
| 1. Practical based on HTML, | : | 10 marks |
| 2. Statistical Example(SPSS, GeneStat and others): | : | 10 marks |
| 3. Bioinformatics exercise | : | 10 marks |
| 4. <i>Viva voce</i> | : | 05marks |
| 5. Certified Practical record book | : | 05 marks |

Internal assessment **10 marks**

	Total	:	50 marks
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M.Sc. Zoolgy Semester : III**Elective : Parasitology****Paper-XI****PROTOZOOLOGY**

- | | |
|--------|---|
| Unit I | <ol style="list-style-type: none"> 1. Introduction, history and scope of Protozoology. 2. Classification of Parasitic Protozoa. <ol style="list-style-type: none"> 2.1 Sarcomastigophora 2.2 Apicomplexa 2.3 Microspora |
|--------|---|

- 2.4 Myxozoa
2.5 Ciliophora
3. General organization of flagellates occurring in alimentary canal of man.
3.1 Retaratomonas
3.2 Chilomastix
3.3 Giardia
- Unit II 4. General features, pathogenicity and transmission of vaginal Trichomonas.
4.1 Trichomonas vaginalis.
4.2 Trichomonas foetus
5. General organization, life cycle and pathogenesis of following.
5.1 Toxoplasma gondii.
5.2 Sarcocystis.
6. General organization of haemosporina and transmission, treatment and control of Malaria.
- Unit III 7. Structure, life cycle, pathogenesis and control of *Balantidium coli*.
8. Coccidia of poultry with reference to the structure, life cycle, pathogenicity, treatment and control.
8.1 Eimeria terella.
8.2 *Eimeria necatrix*.
9. General organization, life cycle and pathogenesis of piroplasma with a special reference to *Babesia* and *Theileria* species.
- Unit IV 10. General organization of Microspora – structure of spore. Life cycle of *Nosema*, diseases caused by microspora in fishes and arthropods.
11. General organization Myxozoa :
11.1 Life cycle of Myxobolus.
11.2 Diseases caused by Myxozoa in fishes.
- Unit V **12.0 Parasitic adaptations and Pathogenicity**
12.1 Evolution of parasites .
12.2 Parasitic adaptations.
12.3 Host –parasite relationship and host specificity.
12.4 Pathogenicity of endo and ecto parasites – general account
12.5 Control of endo-parasites and ecto-parasites

M.Sc. Zoology Semester : III

Elective : Parasitology

Paper-XII

Helminthology

- Unit I 1.1 Introduction, history and scope of Helminthology.
1.2 General organization and classification of Helminths upto family level
1.2.1 Cestoda
1.2.2 Trematoda
1.2.3 Nematoda
1.2.3.1 Animal Parasites
1.2.3.2 Plant Parasites
- Unit II 2.1 Functional Anatomy of Reproductive system.
2.1.1 Pseudophyllidean cestodes
2.1.2 Digenean trematodes
2.1.3 Nematodes
2.1.3.1 Egg shell formation. Chemistry of egg shell formation, factors influencing embryonation and hatching in Cestode and Trematodes.
- Unit III 3.0 Life cycle patterns:
3.1 Cestodes.
3.1.1 No intermediate host life cycle.
3.1.2 Single intermediate host life cycle.
3.1.3 Two intermediate host life cycle.
3.2 Trematodes
3.2.1 Single intermediate host life cycle
3.2.2 Two intermediate host life cycle
3.3 Different life cycle patterns found in Nematodes.
- Unit IV 4.0 Larval form with special reference to pathogenicity:
4.1 Miracidia and cercaria
4.2 Proceroid, Pleuroceroid, Cysticeroid, Cysticerous.
4.3 Rhabditiform, Filariform and plant parasitic nematode.
5.0 Study of following important parasites with respect to their geographical distribution, habitat, structure, lifecycle, pathogenicity, diagnosis, treatment and prevention.
5.1 Cestodes
a) Amphilina
b) Dipylidium canium
c) Diphylobothrium latum
5.2 Trematodes
a) Polystomium

- b) *Aspidogaster*
 c) *Paragonimus westermanii*
- 5.3 Nematodes (Animal)
 a) *Stroglyoides stercorlies*
 b) *Necator americanus*
- Unit V 6.0 Morphology and Pathogenecity of following:
- 6.1 Cestodes
 a) *Taenia saginata*
 b) *Moniezia expansa*
- 6.2 Trematodes
 a) *Echinostomun*
 b) *Ophisthorchis*
- 6.3 Nematodes (Animal)
 a) *Trichuris*
 b) *Loa loa*

LABORATORY COURSE FOR PROTOZOOLOGY OF HELMINTHOLOGY

(40 Marks for Practical and 10 Marks for Internal Assessment)

1. Collection, observation in living condition, fixation staining and identification of intestinal flagellates from various animals.
2. Preparations of blood smear, staining and identification of haematozoa.
3. Impregnation of ciliates with dry silver for the study of kinetics.
4. Collection of myxosporan parasites in fishes.
5. Study of representative flagellated, ciliated, myxozoa, microspora and coccidian.
6. Study of morphological character of important species (Cestodes, Trematodes and nematode of animal and plant Nematodes.) Any six from each group.
7. Examination of hosts (Poultry, sheep, goat, Cattles, Fishes.) for helminthic infection. (Collection. Fixation. Preservation. Staining and identification of cestodes.)
8. Collection of plant parasitic nematode by Baermann's funnel techniques and their identification.
9. Examination of faecal samples for the cestode, trematode and nematode eggs.
10. Collection and examination of vector molluscs for larvae of trematodes.
11. To study the effect of Helminth parasite (any one) on host-histopathology, study of host tissue.

DISTRIBUTION OF MARKS FOR PRACTICAL – VI

The practical shall be of 50 marks of six hours duration and distribution of marks will be as follows.

1. Mounting of parasites (two slides)	10 marks
2. Immunology experiment	10 marks
3. Identification of Spots	10 marks
4. Record	05 marks
5. <i>Viva voce</i>	05 marks

Total: -----
40 marks

Internl assessment -----
 10 marks

Total: -----
50 marks

BOOKS RECOMMENDED For Protozoology.

Baker	-	Parasitic Protozoa
Clakins	-	Protozoa in Biological Research
Chen	-	Research in Protozoology I-IV.
Corliss	-	The ciliate Protozoa
Dogiel	-	An Introduction to Protozoology
Greel	-	Protozoology
Hall	-	Protozoology
Hmammand & Long	-	The coccidian
Hoare	-	Trypanosomes of mammals
Hutzer & I. Waff	-	Biochemistry and Physiology of Protozoa Vo. I, II & III.
Krier eteal	-	Parasitic Protozoa Vol. I to IV.
John & john	-	How to know the Protozoa
Kudo	-	Protozoology
Levine	-	An Introduction to protozoan parasites of domestic animals and of man.
Manwell	-	An Introduction to protozoa
Richardson	-	Veterinary Protozoology
Sleigh	-	Biology of Protozoa
Vickerman	-	The Protozoa
Wenyon	-	Protozoology Vol. I & II
C. J. Hiware	-	Manual & Practical
B. V. Jadav	-	Applied parasitology.

List of books : Helminthology

1. The biology of animal Parasites	-	Cheng T. C.
2. The Trematoda	-	Dauses B.
3. Text book of Medical Parasitology	-	Dey
4. Text book of Medical Parasitology	-	Sawitz

5. Parasitology - Nobel and Nobel.
6. Structure of Nematode - Allenbird.
7. An Introduction of Nematodology - Chitwood.
8. Organization of Nematodes - Crool.
9. Biology of nematodes - Croll.
10. Physiology of Nematodes - Lec.
11. Plant Parasitic Nematodes - Parmonov.
12. Principles of Nematodology - Throne.
13. Plant Nematodology - Jenkin & Taylor.
14. General Parasitology - Cheng.
15. Clinical Parasitology - Craig Faust.
16. Applied Parasitology – A Practical Manual - Hiware, Jadhav & Mohekar
17. Biochemistry of Parasitism - Von Brand.
18. Physiology of Cestode Parasites - Smith
19. Physiology of Nematode Parasites - Smith
20. Helminth, Arthropod & Protozoa of Domesticated Animals – Solbsy E. J. W.
21. Laboratory Methods for work with Plant and Soil Nematodes – Southey.
22. Human Helminthology Manual for Clinicals, Sanitarians & Medical Zoologists - Faust, Emerest Caroll.
23. Soil and freshwater Nematodes - Goodey.
24. The Invertebrates Vol. II - Hyman L. H.
25. Practical exercise in Parasitology - Halton, Behane, Marshall.
26. Animal Nematodes from Indian mammals - Nama, Shinde and Jadhav
27. Cestodes from Indian fishes - Baba Jadhav
28. Applied of parasitology - Hiware, Jadhav & Mohekar.

M. Sc. Zoology
Semester- III
Paper - XI
Elective Paper I
(General Physiology)

- Unit-I Muscle Physiology
- 1.1. Ultra structure of skeletal muscle
 - 1.2. Sarcotubular system
 - 1.3. Ion distribution

- 1.4. Types of contraction-Summation, Treppe, isotonic and isometric contraction.
 - 1.5 Muscle proteins
 - 1.6 Physical and Chemical Properties skeletal muscles
 - 1.7 Chemical changes during muscular contraction
Liberation of energy
Break down of ATP
Resynthesis of ATP
 - 1.8 Sliding filament theory of muscle contraction
 - 1.9 Role of Ca⁺⁺, Calcium receptors, Calmodulin and calcium pump.
 - 1.10 Molecular basis of muscle contraction.
- Unit-II
- 2.1 Ultra Structure of neuromuscular junction (motor end plate)
Synthesis and Release of acetylcholne
Events at the neuromuscular junction (chemical and Electrical) Presynaptic Events during muscle contraction
Action of acetylcholne on the end plate membrane
Destruction of the released acetylcholne
 - 2.2 Myasthenia gravis
 - 2.3 Neuromuscular transmission influenced by toxins, drugs.
 - 2.4 Muscular disorders
Hypotonicity, Hypertonicity, Fibrillation and Denevation hypersensitivity.
 - 2.5 Red and White fibers and muscle function.
- Unit-III
- Nerve Physiology
- 3.1 Ultrastructure of neuron
 - 3.2 Electrical properties of nerve: Conductivity, Summation, Inflatigability, All or none law
 - 3.3 Ionic concentration in the cytoplasm(Donnan equilibrium system)
 - 3.4 Action potential, Resting potential, Depolarization and Repolarization
 - 3.5 Local circuit theory and Saltatory conduction
 - 3.6 Ionic theory and nerve conduction
- Unit IV:
- 4.1 Ultrastructure of synapse
 - 4.2 Biosynthesis, storage and release of acetylcholine
 - 4.3 Electrical events in post synaptic neurons
 - 4.4 Excitatory post synaptic potential
 - 4.5 Inhibitory post synaptic potential
 - 4.6 Synaptic delay
 - 4.7 Acetylcholine receptor and role of acetylcholine esterase

- 4.8 Mechanism of nerve impulse transmission through synapse
- 4.9 Role of calcium, sodium and potassium channels
- 4.10 Types of neurotransmitters, their synthesis and storage (Epinephrine, norepinephrine, serotonin and GABA)

- Unit V :
- 5.1 Neurotrophins and Growth factor
 - 5.2 Factors affecting neuronal growth (Brain derived neurotrophic factor, neurotrophin-3 and neurotrophin 4/5)
 - 5.3 Physiology of imprinting
 - 5.4 Physiology of Emotions
 - 5.5 Parkinsons' disease
 - 5.6 Duchenne's muscular dystrophy

M. Sc. (Zoology)- Semester - III

Paper - XII

Elective Paper II

(GENERAL PHYSIOLOGY)

Total Marks : 50

Unit-I **Receptor Physiology & Pathways**

- 1.1. Mechano receptors
- 1.2 Photo receptors
- 1.3 Thermo receptors
- 1.4 Chemo receptors
- 1.5 Electro receptors
- 1.6 Magneto receptors
- 1.7 Equilibrium receptors

Unit- II **Physiology of High altitude**

- 2.1 Effects of acute exposure to high altitude
 - 2.2 Acclimatization to high altitude
 - 2.3 Respiratory changes
 - 2.4 Exercise at high altitude
- Physiology of Exercise**
- 2.5 Cardiovascular response to exercise
 - 2.6 Skeletal muscle blood flow
 - 2.7 Local factors, Neural factors, humoral factors
 - 2.8 Blood pressure during exercise
 - 2.9 Respiratory response during exercise
 - 2.10 Endocrine response to exercise
 - 2.11 Metabolic adjustments in exercise
 - 2.12 Fatigue-biochemical and Physiological changes.

Unit- III **Physiology of Excretion**

- 3.1 Histophysiology of excretion

- 3.2 Urine formation, Ultrafiltration, Reabsorption, and Secretion, Significance of Henley's loop in production of hyperosmotic urine

- 3.3 Function of aldosterone, antidiuretic hormone and rennin-angiotensin system in renal physiology

- 3.4 Role of kidney in pH regulation and water salt regulation

Unit- IV **Physiology of reproduction**

- 4.1 Histophysiology of testis and ovary

- 4.2 Hormonal regulation of reproduction

- 4.3 Placental types and structure, Histophysiology of placenta

- 4.4 Functions of placenta

Unit V

- 5.1 Sexual behavior in animals

- 5.2 Biological clock and its importance

- 5.3 Adaptive physiological mechanism in relation to space and under water

- 5.4 Physiology of thirst

M. Sc. Semester-III

(Physiology Practical) Practical VI

Total Marks : 50

List of practicals

1. Simple muscle curve Effects of temperature and calcium.
2. Estimation of serum creatinine.
3. Estimation of serum urea.
4. Qualitative analysis of urea
5. Quantitative estimation of calcium, phosphorus sodium and potassium.
6. Separation and identification of amino acids by paper and thin layer chromatography- ground and two dimensional chromatography
8. Separation of proteins by paper or PAG electrophoresis.
9. Experiments on Blood.
 - 9.1 Determination of Erythrocyte sedimentation rate (E.S.R.)
 - 9.2 Determination of pack cell volume (P.C.V).
 - 9.3 Determination of mean corpuscular volume (M.V.C.)
 - 9.4 Detection of blood by hemin crystals test.
 - 9.5 Estimation of protein in blood.
 - 9.6 Estimation of glucose in given sample.
 - 9.7 Estimation of cholesterol in blood.
10. Cardiodynamics ; kymograph record of heart beat in site effects of drugs on heart action.

11. Simple muscle curve-effect of temperature on calcium
12. Study of estrus cycle using vaginal smear in female rat.

Distribution of marks for practical physiology

The practical shall be of 50 marks of 6 hours duration and distribution of marks will be as follows-

	Marks
1 Major physiology experiments.....	15
2 Minor physiology experiments.....	10
3 Experiment on blood.....	05
4 Class record.....	05
5 <i>Viva voce</i>	05
6 Internal assessment	10

Total :	50 Marks

M. Sc. II – Semester – IV

Paper - XIII - Biochemistry (Compulsory)

Unit - I: Biomolecules

- 1.1. pH, pK, acids, bases, buffers, isomerization
- 1.2. Physicochemical properties of water
- 1.3. Van-der-Waals electrostatics, Hydrogen bonding and Hydrophobic interactions
- 1.4 Bonds and forces stabilizing biomolecules.
- 1.5 Monosaccharides and polysaccharides of biological importance.
- 1.6 Glycoconjugates (Proteoglycans, glycoproteins glycolipids).
- 1.7 Muscle proteins
- 1.8 Respiratory proteins

Unit – II : Amino acids and Proteins

- 2.1 Structure and chemistry of amino acids.
- 2.2 Essential and non-essential amino acids
- 2.3 Biosynthesis of nutritionally non-essential amino acids.
- 2.4 Transamination and deamination.
- 2.5 Ornithine cycle
- 2.6 Protein structure& folding, Ramchandran plot
- 2.7 Conjugated proteins : structure and function
- 2.8 Protein-protein interactions

Unit – III : Nucleic Acids

- 3.1 Structure of DNA
- 3.2 Triplex and quadruplex DNA
- 3.3 Structural polymorphism of DNA
- 3.4 Circular DNA and supercoiling.

- 3.5 Structure, types and functions of RNAs
- 3.6 Nucleic acid-protein interactions
- 3.7 *De novo* and salvage pathways of nucleotide biosynthesis
- 3.8 Degradation of nucleotides

Unit – IV : Carbohydrate metabolism

- 4.1 Glycolysis, regulation & energetics
- 4.2 TCA cycle & regulation.
- 4.3 Electron transport chain & oxidative phosphorylation
- 4.4 Gluconeogenesis
- 4.5 Glycogenesis & glycogenolysis , regulation
- 4.6 Pentose phosphate pathway and its significance.

Unit – V : Lipid Metabolism

- 5.1 Chemistry, biosynthesis and functions of triglycerides, phospholipids, sphingolipids, prostaglandins and cholesterol.
- 5.2 Mitochondrial and peroxisomal systems of fatty acid oxidation
- 5.3 β -oxidation of fatty acids
- 5.4 α - and ω -oxidation of fatty acids.
- 5.5 Energetics of fatty acid oxidation
- 5.6 Role of carnitine shuttle
- 5.7 Ketone bodies – Structure, biosynthesis and functions

SEMESTER IV

PAPER XIV (COMPALSORY)

ENZYMOLGY AND BIostatISTICS

Unit I

1.0 Enzyme : Structure , Classification & kinetics

- 1.1 Origin of enzymes : RNA as first enzyme of life
- 1.2 Classification and nomenclature of enzymes
- 1.3 Structure of enzyme, e.g., Chymotrypsin
- 1.4 Active site, Mechanism of action of – Chymotrypsin, Enolase and Hexokinase
- 1.5 Kinetics of single substrate and bisubstrate enzyme catalyzed reactions, cooperativity

Unit II

2.0 Enzyme : Categories & Functions

- 2.1 Enzymes involved in energy production
- 2.2 Enzymes involved in biodegradation.
- 2.3 Activators and inhibitors of enzymes
- 2.4 Isozymes, ribozymes and abzymes

- 2.5 Allosteric enzymes
- 2.6 Zymogen activation & covalent modification

Unit – III

3.0 Enzyme: Functional diversity & applications

- 3.1 Coenzymes, mechanism of action
- 3.2 Immobilized enzymes and their applications
- 3.3 Enzymes involved in protein synthesis
- 3.4 Enzymes involved in free radical formation
- 3.5 Enzymes involved in cell signaling
- 3.6 Enzymes involved in nucleic acid metabolism

Unit – IV

4.0 Biostatistics :

- 4.1 Frequency distribution, Line graph, Bar diagram, Pie diagram
- 4.2 Estimation of allele frequency (dominant and codominant cases)
- 4.3 Examples on Hardy-Weinberg equilibrium
- 4.4 Standard deviation,
- 4.5 Standard error,
- 4.6 Significance test (student 't' test)- paired and unpaired

Unit – V

- 5.0. Biostatistics
- 5.1 Coefficient of correlation
- 5.2 Regression line, regression approaches to estimating dose-response relationship
- 5.3 Determination of LC_{50} 48 hr and LC_{50} 96 hr by interpolation method
- 5.4 Probit analysis
- 5.5 Analysis of variance (ANOVA)
- 5.6 Confidence Intervals (CI)

Suggested Reading Material (All latest editions)

1. Animal Cell Culture – A practical approach, Ed. John R.W.Masters. IRL Press.
2. Introduction to instrumental analysis, Robert Braun. McGraw Hill International Editions.
3. A Biologists Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.
4. Molecular Cell Biology, J. Darnell, H.Lodish and D. Baltimore Scientific American Book, Inc. USA.
5. Molecular Biology of the Cell, B.Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J. D. Watson. Garland Publishing Inc., New York

6. Samuel Delvin, Enzymes, Sarup & Sons, N.Delhi
7. Practical biochemistry edited by Walker
8. The cell , a molecular approach : Cooper
9. Molecular cell biology : Gerald Karp
10. Foundation in microbiology : Talaro
11. Microbiology : Pelczar
12. Biology of micro- organisms : Madigan, Martinko and Parker.
13. Biophysical chemistry- Principles and technique : Upadhyay, Nath
14. Z.Govindarajulu (2000): Statistical techniques in Bioassay Pub . S.Kargar
15. D.J.Finney (1971) : Statistical method in Bioassay Pub. Griffin
16. R.N. Vankhede & S. N. Niwane Laboratory manual for Biochemistry and Molecular biology, Shivnery Publishers
16. D.J.Finney (1971) : Probit analysis, 3rd edition Pub. Griffin

Practical VII (Based on papers XIII, XIV, XV and XVI)

- 1) Determination of isoelectric pH of protein and amino acids.
- 2) Isolation of casein from milk
- 3) Study effect of pH and temperature on enzyme activity. Ex. Salivary amylase.
- 4) To study the effect of inhibitors on enzyme activity.
- 5) Determination of acid value of fat.
- 6) Determination of saponification value of fat.
- 7) Colorimetric estimation of some respiratory enzymes.
- 8) Estimation of plasma / serum glucose
- 9) Estimation of glycogen from tissue.
- 10) Estimation of serum cholesterol
- 11) Estimation of phospholipids
- 12) Estimation of lactate dehydrogenase
- 13) Estimation of plasma proteins
- 14) Estimation of Na ions.
- 15) Estimation of K ions.
- 16) Estimation of calcium
- 17) Colorimetric estimation of some respiratory enzymes
- 18) Estimation of lactate dehydrogenase
- 19) Estimation of ATPase
- 20) Estimation of SGOT / SGPT
- 21) Estimation of Acetylcholinesterase
- 22) Estimation of acid alkaline phosphatase
- 23) Estimation of catalases
- 24) Examples from Biostatistics as per theory

25) Preparation of Powerpoint program on a given topic

26) Drawing graphs and tables on computer

Candidates shall be required to produce at the practical examination, the following-

Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the bonafide work of the candidate.

The practical shall be of 40 marks of six hours duration and distribution of marks will

Distribution of Marks be as follows : In addition to these marks there will be internal assessment of 10 marks.

Total Marks : 50	
1) Estimation/experiment	: 10
2) From elective paper (Estimation / experiment / Dissection)	: 10
3) Example / Experiment /slide / computer based practical	: 10
4) Class Record, collection, slides (as per syllabus)	: 05
5) <i>Viva-Voce</i>	: 05
=====	
Internal Assessment	10
=====	
Total	: 50
=====	

M.Sc. (Zoology) Semester IV

Paper – XV

(Elective paper : Paper III)

MOLECULAR BIOLOGY-II (Molecular Immunology –1)

Unit-I

- 1.0 The immune system
- 2.0 Innate and Acquired immunity, Interrelationship Between Innate and Acquired Immunity
- 3.0 Organization and structure of lymphoid organs
- 4.0 Cells of the immune system and their differentiation and functions
- 5.0 Lymphocyte traffic
- 6.0 Nature of antigens and immunogens
 - 6.1 Antigenicity and immunogenicity
 - 6.2 Requirements for Immunogenicity, Foreignness, High Molecular Weight, Chemical Complexity, Degradability
 - 6.3 Factors influencing immunogenicity
 - 6.4 Epitopes and haptens

6.5 Adjuvants,

6.6 Superantigens

Unit-II

7.0 Structure and Functions of antibodies :

- 7.1 Classes and subclasses
- 7.2 Structural Features of IgG :Structure of Light and Heavy Chains, Domains, Hinge Region, Variable Region, Immunoglobulin Variants, Isotypes, Allotypes, Idiotypes,
- 7.3 Biologic Properties of IgG,
- 7.4 Structural Features of IgM, Biologic Properties of IgM
- 7.5 Structural Features of IgA, Biologic Properties of IgA
- 7.6 Structural Features of IgD, Biologic Properties of IgD
- 7.7 Structural Features of IgE, Biologic Properties of IgE
- 7.8 The Immunoglobulin Superfamily,
- 7.9 Antibody mediated effector functions
- 8.0 Antigen-Antibody interactions *in vitro* & *in vivo*
- 9.0 Complement system: Alternate, Classical and Lectin pathways

Unit III

10.0 T - lymphocytes:

- 10.1 Isolation, molecular components and structure
- 10.2 Nature of the Antigen-Specific T Cell Receptor,
- 10.3 Molecules That Interact with Antigen,
- 10.4 Co receptor Molecules,
- 10.5 The T Cell Receptor Complex,
- 10.6 Other Important Molecules Expressed on the T Cell Surface,
- 10.7 Generation of T cell Receptor Diversity,
- 10.8 T Cell Differentiation and maturation in thymus
- 10.9 Cell death and T-cell population

Unit IV

11.0 B-cell generation, activation and differentiation

- 11.1 B-cell receptors
- 11.2 Selection of immature self-reactive B-cells
- 11.3 B-cell activation and proliferation
- 11.4 T-B cell interactions
- 11.5 Humoral immune response

12.0 Cell mediated effector functions

- 12.1 Cell adhesion molecules
- 12.2 Effector cells and molecules
- 12.3 CTL and NK cells - mechanisms of action

13.0 Immunological memory

14.0 Immunologic tolerance and anti-immunity**Unit V 15.0 Cytokines:**

- 15.1 General Properties of Cytokines,
- 15.2 Common Functional Properties of cytokines,
- 15.3 Functional Categories of Cytokines : Cytokines That Regulate Immune Responses, Cytokines That Facilitate Innate Immune Responses and Activate Inflammatory Responses, Chemokines, Cytokines That Affect Leukocyte Movement, Cytokines That Stimulate Hematopoiesis,
- 15.4 Cytokine Receptor-Mediated Signal Transduction
- 15.5 Role of Cytokines and Cytokine Receptors in Diseases

M.Sc. (Zoology) Semester IV**Paper – XVI****(Elective paper : Paper IV)****MOLECULAR BIOLOGY-II (MOLECULAR IMMUNOLOGY-II)****Unit I**

- 1.0** Hypersensitivity and immune response to infectious agents especially intracellular parasites
- 2.0** Hybridoma technology, Immunization of animals, Isolation of stimulated spleen cells, Myeloma cell line used as fusion partners, Fusion methods, detection and applications of monoclonal antibodies

Unit II**3.0 Principles of Immunization**

- 3.1** Active Immunizations, Basic Mechanisms of Protection, Significance of the Primary and Secondary Responses, Age and Timing of Immunizations, Precautions, Site of Administration of Antigen, Hazards,
- 3.2** Recent Approaches to Production of Vaccines, Vaccines Produced by Recombinant DNA, Conjugated Polysaccharides, Synthetic Peptide Vaccines, Anti-Idiotypic Vaccines, Virus-Carrier Vaccine, Bacterium-Carrier Vaccine, DNA Vaccines,

Toxoids,

Edible vaccines

Immunorobot and nubot

3.3 Passive Immunization,

Passive Immunization through Placental Antibody Transfer, Passive Immunization via Colostrum, Passive Antibody Therapy and Serum Therapy, Preparation and Properties of Human Immune Serum Globulin, , Precautions in the Use of Immune Therapy,

Unit III**4.0 Autoimmunity and Diseases**

- 4.1 Criteria for Autoimmune Disease,
- 4.2 Causes of Autoimmune Diseases,
- 4.3 Examples of Autoimmune Diseases,
- 4.4 Autoimmune Diseases in Which Antibodies Play the Predominant Role in Mediating Organ Damage,
- 4.5 Autoimmune Diseases in Which T Cells Play a Predominant Role in Organ Damage,
- 4.6 Autoimmune Diseases Arising from Deficiency in Components of Complement

5.0 HYPERSENSITIVITY REACTIONS:**5.1 ANTIBODY-MEDIATED (TYPE I) REACTIONS**

General characteristics of Allergic Reactions, Sensitization Phase : IgE Antibody Production ,Activation Phase, Effector Phase, Preformed Mediators, Newly Synthesized Mediators, Late-Phase Reaction, The Protective Role of IgE

5.2 ANTIBODY-MEDIATED (TYPE II) CYTOTOXIC REACTIONS

Cytotoxic Reactions: Type II Hypersensitivity, Complement-Mediated Reactions, Antibody-Dependent Cell-Mediated Cytotoxicity, Antibody-Mediated Cellular Dysfunction, Examples of Cytotoxic Hypersensitivity Reactions, Transfusion Reactions, Drug-Induced Reactions, Rhesus-Incompatibility Reactions,

Unit IV**5.3 Type III Hypersensitivity**

Systemic Immune Complex Disease,

Localized Immune Complex Disease,

5.4 CELL-MEDIATED (TYPE IV) DELAYED-TYPE HYPERSENSITIVITY

General Characteristics and Pathophysiology of DTH,

Mechanisms of DTH,

Consequences of DTH,

Examples of DTH,

Contact Sensitivity,

Granulomatous Hypersensitivity,

Tuberculin-Type Hypersensitivity,

Allograft Rejection

Unit V

6.0 Major Histocompatibility Complex in mouse and HLA system in human:

6.1 MHC haplotypes

6.2 Structure of Class I and Class II molecules

6.3 Cellular distribution

6.4 Peptide binding

6.5 Expression and diversity

6.6 Disease susceptibility and MHC/HLA

7.0 Immunodeficiency:

7.1 Immunodeficiency disorders

7.2 **Acquired immunodeficiency syndrome** - Origin of AIDS virus, Nature of HIV, Structure, Mechanism of infection, HIV-1 genome, Th cell specificity for HIV infection, Mechanism of destruction of T4 cells, Functional abnormalities of different cell types in AIDS patient, Development of AIDS vaccine.

Practical to be carried out in practical No. 7

- 16) To assess the degree of similarity of the antigens.
- 17) Screening of antigen and antibody (screening test in antibody production – Onchsterlony
- 18) Estimation of antigen and antibody content in the samples by quantitative precipitation assay
- 19) Estimation of antigen and antibody content in the samples by radioimmunodiffusion
- 20) Counter - current immunoelectrophoresis
- 21) Identification of blood groups - A, B, AB, O and Rh
- 22) Separation of immunological proteins (alpha,beta,gamma) by paper or gel electrophoresis

Practical VIII – Project work

Distribution of Marks :

The project work shall be of 40 marks and the distribution of marks will be as follows :

1. Project	:	40 marks	
2. Internal assessment	:	10 mark	
	Total :	50 marks	

M.Sc.Zoology, Semester- IV.

Paper – XV

Special Group-Entomology: Paper III

INSECT ENDOCRINOLOGY AND INDUSTRIAL ENTOMOLOGY

- Unit I :
1. Neuroendocrine system: Structure and hormones of Corpora cardiaca, Prothoracic glands, and corpora allata.
 2. Hormonal regulation of metamorphosis
 3. Hormonal regulation of reproduction
 4. Exocrine glands: structure, pheromones: glands and function
- Unit II :
1. Diapause : Factors and physiology.
 2. Social life: polymorphism and colony organization in termites and honeybees.
 3. Entomophagous parasitism in hymenoptera: Hyperparasitism and Multi parasitism, Super parasitism and auto parasitism, Social parasitism.
 4. Insect migration : Locust and Locust swarming
- Unit III:
1. Mulberry sericulture: mulberry silkworm, life history, Silk gland, silk proteins,
 2. Mulberry plants, plantation and leaf production.
 3. Silkworm rearing. Cocoon formation, cocoon harvesting, reeling,
 4. Silkworm rearing house and seed production. Pests of silkworm and their management.
- Unit.IV :
1. Tasar, silkworm biology, host plants, culture and life cycle.
 2. Muga, silkworm biology, host plants, culture and life cycle.
 3. Eri silkworm biology, host plants, culture and life cycle
 4. Silkworm diseases: Symptoms, pathogenecity and management of Viral, Bacterial, Fungal, Protozoan diseases of silk worm:

- Unit V :
1. Apiculture: Types of honeybees, Rock bees (Life cycle, their hive and colonies, migration and honey production).
 2. Apiary products. Honeybee pests and their management. wax and other apiary products
 3. Bee keeping techniques: Movable frame lives and bee rearing management, economic importance of honey.
 4. Lac culture: Biology of lac insects, lac cultivation and economic importance.

M.Sc. Zoology. Semester-IV.
Paper – XVI
Special Group-Entomology: Paper IV
Insect pests and pests control

Unit I :

1. Origin of pests, types of pests and nature of damage
2. Agricultural pests of Rice (Paddy stem borer), Jowar (Sorghum shoot fly), Cotton (Spotted bollworm, Pink bollworm), Sugarcane (Sugar cane leaf hopper), Nature of damage Life cycle and control measures:
3. Fruit pests of Citrus (Fruit sucking moth, Lemon butterfly), Mango (Mango stemborer, mango jassid), Nature of damage Life cycle and control measures:
4. Vegetable pests of Cabbage (Cabbage butter fly) and Brinjal (Brinjal shoot and fruit borer): Nature of damage Life cycle and control measures:

Unit II :

1. Stored grain pests (Rice weevil, red flour beetle) Nature of damage Life cycle and control measure:
2. Pests of Horse and Cattle: Horsefly, Stable fly, Cattle biting louse, and cattle blood sucking louse. (Nature of damage Life cycle and control measures)
3. Flies, Lice, Tick and fleas causing diseases in man: pathogens, diseases, mode of transmission and vector control.
4. Mosquitoes (Anopheles, Aedes), causing diseases in man, pathogens, diseases, mode of transmission and vector control.

Unit III :

1. Preventive measures: Cultural and Mechanical.
2. Chemical control. Insecticides-classification: Inorganic insecticide, properties, mode of action, merits and demerits.

3. Chlorinated hydrocarbon, organophosphates properties, mode of action, and use.
5. Carbamates and related compounds: properties, mode of action, and use.

Unit IV:

1. Natural organic compounds and pyrethroids: properties, mode of action, and use.
2. Biological control: Historical and philosophical basis.
3. Desirable attributes of natural enemies of pests: Steps in establishing biological control programme.
4. Predators used in biological control programs, their taxonomic and biological relationships and life cycles.

Unit V

1. Insect pathogenic Bacteria, used in biological programmes; their taxonomic and biological relationship, their mass production and examples
2. Microbial control: insect pathogenic Protozoan, Viruses, fungi; their taxonomic and biological relationship, their mass production and examples,
3. Modern trends in pest control: use of chemosterilants, radiation, hormones and pheromones.
4. Integrated pest management: Principle, modeling and application.

Selected readings:

1. Patnaik, B. D. **“Physiology of Insects”**. Dominant Books, New Delhi.
2. Patnaik, B. D. **“Insects: Reproduction and Development”**. Dominant Books, New Delhi.
3. Price, **“Insect Entomology”**. Wiley.
4. Tembhare, D. B. **“T. B. of Entomology”**. Himalaya Publishers, New Delhi.
5. Apple, I. L. and R. E. Smith. **“Integrated Pests Management”**. Plenum Publishing Corp., New York.
6. Asicew, R. R. **“Parasitic Insects”**. Rlserier-North Holland Publishing Co. New York.
7. Atwal' A. S. **“Agricultural Pests of India and South-East Asia**. Kalyani Publishers, New Delhi.
8. Blom, M. S. **“Fundamentals of Insect Physiology”**. Wiley-Intevscience, New York
9. Chapman, R. F. **“The Insects –Structure and Function”**. English University Press, London.

10. Comstock, J. H. "An Introduction to Entomology". Ithaca, New York.
11. Du Porte, E. M. "The Comparative Morphology of the Insect Head". A Rev. Ent. 2:55-70.
12. Eds. O. W. Richards and R. G. Davis Chapman and Hall, "Imms General Text book of Entomology". London
13. Eds. M. Rockstein, **The Physiology of Insects**. Vol. 1-5 Academic Press New York.
14. Elizirja, R. J. "Fundamentals of Entomology" 2/ed. Prentice-Hall inc. Englewood Cliffs, New York.
15. Engleman, F. "The Physiology of Insect reproduction". Pergamon Press, Oxford.
16. Evans, H. E. "Insect Biology: A text Book of Entomology". Wesley Publishing Co.
17. Gillot, C. "Entomology". Plenum Press, New York.
18. Kerkut, G. A. and Gilbert, L. I. "Comprehensive Insect Physiology, Biochemistry and Pharmacology".
19. K.K.Nayar, T. N. Ananthkrishan and B. V. Davis Tata McGraw General and applied Entomology. Hill Col Ltd. Bombay.
20. Mani, M.S. "General Entomology" 3/ed. Oxford and IBH Publishing Co. New Delhi.
21. Nair, M. R. G. K. (1986) "Insects and Mites of Crops in India". ICAR, New Delhi.
22. Oldroyd. N. **Collection, Preserving and studying insects**.
23. 2P.Debatch. **Biological control of Natural enemies**.
24. Ross, H. H., C. A. Ross, and J. R. P. Ross. "Text Book of Entomology" 4/ed. John Wiley and Sons, New York.
25. R.V.D Boarscho, P.S.Y. Messenger and A.P. Gaiter, **An Introduction of Biological Control** Plenum Publication Co. Wigglesworth, V. B. "Insect Hormones" Oliver and Boyd Publi.

List of Practicals to be conducted alongwith Practical-VII
Special Group-Entomology-II

1. Dissection of silk gland in mulberry and non mulberry silkworms.
2. Dissection of male and female reproductive system in silk moths.
3. Dissection of salivary, pharyngeal glands and sting apparatus in honey bees.
4. Demonstration of disease causing pathogens in insects.
5. Permanent histopathological preparations of baculovirus and protozoan infected tissues.
6. Collection, preservation, identification, classification, of harmful insects, parasitic hymenopterans and other beneficial insects.

7. Whole mount preparation of parasitic insects and microscopic pests.
8. Determination of lethal dose (LD 50) of pesticide.
9. Preparation of life history of economical important insects.
10. Compulsory visit to Apiculture, Sericulture, Lac culture centres and entomology research laboratory/Centres.

Practical VIII – Project work

Distribution of Marks

The Project work shall be of 40 marks and the distribution of marks will be as follows :

1. Project	:	40 marks
2. Internal assessment	:	10 mark
		50 marks

M. Sc. (Zoology) Semester – IV
Paper – XV

LIMNOLOGY AND ECOTOXICOLOGY – II

- | | |
|----------|--|
| Unit I | Aquatic Ecosystem
1.1 Nutrient cycles
1.2 Hydrological Cycle
1.3 Productivity of Lakes and its importance |
| Unit II | Limnological Parameters
2.1 Zooplanktons and their role in fishery
2.1.1 Free living Protozoa,
2.1.2 Rotifers,
2.1.3 Cladocera, |
| Unit III | Biological parameters-
3.1 Copepodes
3.2 Ostracodes
3.3 Zoobenthos
3.4 Macroinvertebrates and Aquatic insects
3.5 Phytoplanktons (Algae and Diatoms) |
| Unit IV | Pollution- Sources, Hazards and Control Measures
4.1 Pollution of lakes and reservoirs
4.2 Pollution of rivers
4.3 Pollution of sea |
| Unit V | 5.1 Role of Biotechnology in Biodegradation
5.2 Biotransformation of the Xenobiotics
5.3 Biomagnification |

5.4 Bioremediation of ponds and lakes

5.5 Environmental Impact Assessment

M. Sc. (Zoology) Semester – IV**Paper – XVI****(Ichthyology, Aquaculture and Fishery – II)****Unit I I Specialized organs in fishes**

1.1. Electric organs

1.2. Sound producing organs

1.3. Weberian ossicle and its homology

1.4. Lateral line receptors-

1.4.1 Ampullae of Lorenzini, and pit organs

1.5 Poison gland in fishes.

Unit II Fish physiology and behaviour

2.1. Migration in Fishes

2.2. Osmoregulation in fishes

2.3. Bioluminescence and luminescent organs in fishes

Unit III Culture fishery

3.1 Culture methods

3.2 Monoculture

3.3 Polyculture

3.4 Paddy-cum-fish culture

3.5 Sewage fed fishery

3.6 Cage and pen culture, Culture of Giant fresh water prawn

3.7 Pearl oyster Culture

3.8 Edible oyster culture

Unit IV Pond Management and improvement

4.1 Nursery

4.2 Rearing

4.3 Stocking

4.4 Aquatic weed and their control

4.5 Control of weed fishes

Unit V Principal fisheries of India

5.1 Prawn fishery

5.2 Crab fishery

5.3 Lobster fishery

5.4 Molluscan fishery

REFERENCE BOOKS:

Alexander R. M. N. : Functional design in fishes.

Alikunhi : Pisciculture

Baba Jadhao :

Cystodes from Indian Fishes.

Berg L. S. :

Classification of Fishes

Bertm L. :

Eels

Brown M. E. :

The Physiology of Fishes Vol. I and II

Boulner and Fridge :

Fishes Vol. VII of CNS Series

Brands A. V. :

Fish catching methods of world.

Curtis Brain :

The life of fishes

Chondar S. L. :

Hand book of Breeding in Indian Carps.

Chopra B. N. :

Handbook of Indian Fisheries

Chopra B. N. :

Agricultural marketing in India

Davis H. S. :

Culture and diseases of game fishes.

Day F. :

Fish fauna of India Vol. I and II.

Gorbman and Bem :

Text book of comp. endocrinology

Goodrich :

Structure and Development of Vertebrates.

Hoar and Randall :

Fish physiology Vol. I- IV.

Hielding :

Fish culture.

Jones, F. R. H. :

Fish migration

Lagler, Bardach and :

Ichthyology

Miller

Malu R. A. :

A practical approach to fresh water fish culture

Nikolsky :

The ecology of Fishes

Nikolsky :

Social ichthyology

Rao Naga Raja :

An introduction of Fisheries

Pickford and Att :

Physiology of Pituitary gland of fishes

Rounstell and :

Methods of fishery science

Everhar

Rath, R. K. :

Fresh water aquaculture, Scientific Pub. Jodhpur

Russel :

Fishery Science

Bardach. Rhyther and

Mclamery :

Aquaculture

Vankhede G. N. and :

Freshwater fish culture

Deshmukh S.V.

Saleem Musthafa :

Genetics of sustainable fisheries management

Devid H. Evans :

The physiology of fishes

Dr. L. S. Smith :

Introduction of fish physiology

Manual production :

Pearl oyster seed.

Training Manuals :

Advances of keeping and breeding ornamental fishes, CIFE, Mumbai

Training Manual	:	Recent advances in management of quality parameters in aquaculture water, CIFE, Mumbai
Training Manual	:	Culture of live food organisms for aqua hatcheries, CIFE, Versova, Mumbai.
Training Manual	:	Modern approach to Aquafeed formulation and on farm feed management CIFE, Versova, Mumbai.
Training Manual	:	Peninsular aquaculture and cage and pen culture of carps, CIFA, Kaushalyanagar, Bubaneswar-2.
Training Manual	:	Giant fresh water pearl culture, CIFA Kaushalyanagar, Bubaneswar-2.
Training Manual	:	Fresh water pearl culture, CIFA, Kaushalyanagar, Bubaneswar-2.
Bulletin	:	Larva development of Indian Penaeid prawns, CMFRI. Cochin-14
Bulletin	:	Artificial reef and sea farming technologies, CMFRI, Cochin-14
Special Bulletin	:	Transportation of Live fishes and Shell fishes, CMFRI, Cochin-14
Rick Parker	:	Aquaculture Sciences, Delmer Thomson lerning.
Mohapatra Ingole Bharad	:	Aquaculture, Dr. Panjabrao Deshmukh Agriculture University, Akola.

Journals and Bulletins

- I. Indian Journal of Fisheries
- II. Fishery resources of India
- III. J. of Marine Biological Association (India)
- IV. WHO publ.
- V. FAO publ.
- VI. Environmental Health

Practical (To be carried out along with practical VII)

1. Collection, identification and classification of available fresh water fishes.
2. Identification of common aquatic weeds.
3. Dissection of locally available fishes:
 - .1 Digestive system
 - .2 Reproductive system
 - .4 Weberian ossicles in Labeo
 - .5 Internal ear
 6. Brain.

List of the practical for M.Sc. Zoology Semester-IV (special paper General physiology) to be carried out along with Practical -VII

Practical –VIII

1. Dissection of digestive System cranial nerves, spinal nerves of local fish and rat/mouse, Dissection of the brain, kidney, of fish, calotes and rat/mouse.
2. Qualitative analysis of urea, ketone bodies and salts.
3. Normal and abnormal constituents of urine.
4. Microscopic examination of urine.
5. Preparation and examination of blood smear to study blood cells.
6. Differential leucocytes count.
7. Histochemical demonstration of-
 - Carbohydrates,
 - Proteins,
 - Lipids.
 - Nucleic acids,
 - Acid and alkaline phosphatase.
8. Separation of proteins by paper and gel electrophoresis.

M.Sc. Zoology Semester : IV

Elective : Bioinformatics-III

PAPER-XV GENOMICS

Unit-I : Emerging areas in Bioinformatics

- 1.1 Public and Private genome databases
- 1.2 Microarray databases
- 1.3 Comparative genomics
- 1.4 Functional genomic
- 1.5 System Biology

Unit-II : Bioinformatics and Metabolic pathways

- 2.1 Identification and importance of vulnerable biochemical pathways in pathogen .
- 2.2 Drug target identification
- 2.3 Drug designing
- 2.4 Ontology
- 2.5 Nutrienogenomics

Unit-III : Gene prediction

- 3.1 Identification of patterns of protein encoding genes in genome.
- 3.2 Anatomy of Prokaryotic and Eukaryotic promoter
- 3.3 Open Reading Frames (ORF)
- 3.4 Assessment of reliability of gene prediction.

3.5 Use of HMM (Hidden Markov Model) in identification of protein coding region.

Unit-IV: **Computer Graphics**

- 4.1 Interactive graphics and interactive devices.
- 4.2 Geometric transformation
- 4.3 Raster algorithms and Frame buffer techniques.
- 4.4 Surface and solid modeling, Rendering
- 4.5 Animation and 3-D image reconstruction.

Unit-V: **Molecular Phylogenetics**

- 5.1 Models of evolution
- 5.2 Anatomy of phylogenetic tree
- 5.3 Distance Vs. Character based phylogenetic tree construction methods
- 5.4 Homoplasy and multiple hits.
- 5.5 Molecular clock (Constant and relax)

M.Sc. Zoology Semester : IV

Elective : Bioinformatics-IV

Paper-XVI Proteomics

Unit-I **Understanding Protein structure**

- 1.1 Ramachandran Plot
- 1.2 Protein motifs , tertiary and quaternary structures.
- 1.3 DNA-Protein interaction
- 1.4 Protein-Protein interaction
- 1.5 DNA Foot printing & Mass Spectroscopy

Unit-II **Protein folding, unfolding and misfolding**

- 2.1 Principles of protein folding
- 2.2 Methods for prediction of secondary and tertiary structures of proteins.
- 2.3 Role of Chaperon .
- 2.4 Prions structure and functions.
- 2.5 Calculation of conformational energy of proteins

Unit-III: **Prediction of RNA Secondary structure**

- 3.1 Features of RNA Secondary and Tertiary structure
- 3.2 Methods for predicting RNA Structure
- 3.3 Searching for RNA- specifying genes.
- 3.4 RNA Structural modeling.
- 3.5 Thermodynamics and databases of RNA secondary structure

Unit-IV: **Protein and Drug discovery**

- 4.1 Evolution of Protein structure and function
- 4.2 Protein Super-Secondary structures

4.3 Mutant Proteins

4.4 Protein Structure and Drug discovery

4.5 Protein databases of sequence and Structures

Unit-V : **Proteomics in action**

- 5.1 Protein databanks
- 5.2 Proteomics and System Biology
- 5.3 PDB Conserved domains
- 5.4 Protein purification Strategy
- 5.5 Docking of molecule

Practical (To be carried out along with practical VII)

1. Practical based on phylogenetic tree construction.
2. Practical related to pattern recognition of coding regions.
3. Practical based on retrieval of Protein structure from databases.
4. Practical based on model validation.
5. Use of different web-servers in protein modeling
6. Practical related to 3D viewing tools
7. Practical related to RNA secondary prediction and 3D structure viewing.

Practical VIII – Project work

The examinees shall be required to produce at the practical examination the following :

Distribution of Marks

The project work shall be of 40 marks and the distribution of marks will be as follows :

1.	Project	:	40 marks
2.	Internal assessment	:	10 mark
	Total	:	50 marks

M.Sc. (Zoology) Semester IV (Elective :Parasitology)

Paper - XV

(Parasitological Immunology –I)

- Unit-I
- 1.0 The immune system
 - 2.0 Innate and Acquired immunity, Interrelationship Between Innate and Acquired Immunity
 - 3.0 Organization and structure of lymphoid organs
 - 4.0 Cells of the immune system and their differentiation and functions

- 5.0 Lymphocyte traffic
- 6.0 Nature of antigens and super-antigens
 - 6.1 Antigenicity and immunogenicity
 - 6.2 Requirements for Immunogenicity, Foreignness, High Molecular Weight, Chemical Complexity, Degradability
 - 6.3 Factors influencing immunogenicity
 - 6.4 Epitopes and haptens
 - 6.5 Adjuvants,
 - 6.6 Superantigens

Unit-II **7.0 Structure and Functions of antibodies :**

- 7.1 Classes and subclasses
- 7.2 Structural Features of IgG :Structure of Light and Heavy Chains, Domains, Hinge Region, Variable Region, Immunoglobulin Variants, Isotypes, Allotypes, Idiotypes,
- 7.3 Biologic Properties of IgG,
- 7.4 Structural Features of IgM, Biologic Properties of IgM
- 7.5 Structural Features of IgA, Biologic Properties of IgA
- 7.6 Structural Features of IgD, Biologic Properties of IgD
- 7.7 Structural Features of IgE, Biologic Properties of IgE
- 7.8 The Immunoglobulin Superfamily,
- 7.9 Antibody mediated effector functions
- 8.0** Antigen-Antibody interactions *in vitro* & *in vivo*
- 9.0** Complement system: Alternate, Classical and Lectin pathways

Unit III

10.0 T-lymphocytes:

- 10.1 Isolation, molecular components and structure
- 10.2 Nature of the Antigen-Specific T Cell Receptor,
- 10.3 Molecules That Interact with Antigen,
- 10.4 Coreceptor Molecules,
- 10.5 The T Cell Receptor Complex,
- 10.6 Other Important Molecules Expressed on the T Cell Surface,
- 10.7 Generation of T cell Receptor Diversity,
- 10.8 T Cell Differentiation and maturation in thymus
- 10.9 Cell death and T-cell population

Unit IV

- 11.0 B-cell generation, activation and differentiation
- 11.1 B-cell receptors
- 11.2 Selection of immature self-reactive B-cells
- 11.3 B-cell activation and proliferation
- 11.4 T-B cell interactions

- 11.5 Humoral immune response
- 11.6 Immunological memory
- 11.7 Immunologic tolerance and anti-immunity

Unit V

12.0 Cytokines:

- 12.1 General Properties of Cytokines,
- 12.2 Common Functional Properties,
- 12.3 Functional Categories of Cytokines : Cytokines That Regulate Immune Responses, Cytokines That Facilitate Innate Immune Responses and Activate Inflammatory Responses, Chemokines: Cytokines That Affect Leukocyte Movement, Cytokines That Stimulate Hematopoiesis,
- 12.4 Cytokine Receptor-Mediated Signal Transduction,
- 12.5 Role of Cytokines and Cytokine Receptors in Disease

Semester IV (Elective :Parasitology)

Paper – XVI

(Parasitological Immunology –II)

- Unit I **1.0** Hybridoma technology, Immunization of animals, Isolation of stimulated spleen cells
Myeloma cell line used as fusion partners, Fusion methods, detection and applications, of monoclonal antibodies
- Unit II **2.0 Principles of Immunization**
 - 2.1 Active Immunizations, Basic Mechanisms of Protection, Significance of the Primary and Secondary Responses, Age and Timing of Immunizations, Precautions, Site of Administration of Antigen, Hazards,
 - 2.2 Recent Approaches to Production of Vaccines, Vaccines Produced by Recombinant DNA, Conjugated Polysaccharides, Synthetic Peptide Vaccines, Anti-Idiotypic Vaccines, Virus-Carrier Vaccine, Bacterium-Carrier Vaccine, DNA Vaccines, Toxoids, Edible vaccines

- 2.3 Passive Immunization,
 Passive Immunization through Placental Antibody Transfer,
 Passive Immunization via Colostrum,
 Passive Antibody Therapy and Serum Therapy,
 Preparation and Properties of Human Immune Serum Globulin,
 Precautions in the Use of Immune Therapy,
- Unit III **3.0 HYPERSENSITIVITY REACTIONS:**
- 3.1 ANTIBODY-MEDIATED (TYPE I) REACTIONS,
 General characteristics of Allergic Reactions,
 Sensitization Phase : IgE Antibody Production ,Activation Phase, Effector Phase,
 Preformed Mediators, Newly Synthesized Mediators,Late-Phase Reaction,
 The Protective Role of IgE,
- 3.2 ANTIBODY-MEDIATED (TYPE II) CYTOTOXIC REACTIONS AND IMMUNE COMPLEX (TYPE III) REACTIONS**
 Cytotoxic Reactions: Type II Hypersensitivity,
 Complement-Mediated Reactions,
 Antibody-Dependent Cell-Mediated Cytotoxicity,
 Antibody-Mediated Cellular Dysfunction, Examples of Cytotoxic Hypersensitivity Reactions,
 Transfusion Reactions, Drug-Induced Reactions,
 Rhesus-Incompatibility Reactions,
 Autoimmune Reactions Involving Cell Membrane Receptors,
 Autoimmune Reactions Involving Other Cell Membrane
- 3.3 Type III Hypersensitivity**
 Systemic Immune Complex Disease,
 Localized Immune Complex Disease,
- 3.4 T CELL-MEDIATED (TYPE IV) DELAYED-TYPE HYPERSENSITIVITY**
 General Characteristics and Pathophysiology of DTH,
 Mechanisms of DTH,
 Consequences of DTH,
 Examples of DTH,
 Contact Sensitivity
- Unit IV 4.0 Functional rearrangement in Salmonella Flagellar antigens.
 4.1 Antigenic variation in *Trypanosoma*.
 4.2 Molecular mechanism of resistance in man against malarial parasites.

- 4.3 Major Histocompatibility Complex in mouse and HLA system in human:
- 4.4 MHC haplotypes
 4.5 Structure of Class I and Class II molecules
 4.6 Cellular distribution
 4.7 Peptide binding
 4.8 Expression and diversity
 4.9 Disease susceptibility and MHC/HLA
- Unit V 5.0 Adaptation of parasites. Advantages and disadvantages in parasitic life..
 5.1 Host reaction to parasite.
 5.2 Feeding aids found in different group of parasites – resistance. Compatibility. Immunity, influence on parasite life cycle.
 5.3 General, control measure of parasites, protection of hosts, parasitic control in and outside the hosts-chemical biological and cultural therapeutic.
 5.4 Economic importance of parasites: Direct indirect effect on human and animal life. Losses to agriculture, poultry, farm animals and fisheries

Practicals on immunology(to be carried out in Practical VII)

- To assess the degree of similarity of the antigens
- Screening of antigen and antibody (screening test in antibody production – Onchiterlony test)
- Estimation of antigen and antibody content in the samples by quantitative precipitation assay
- Estimation of antigen and antibody content in the samples by radioimmuno diffusion
- Counter – current immunoelectrophoresis
- Separation of immunological proteins (alpha,beta,gamma) by paper or gel electrophoresis
- Differential leucocyte count

Distribution of Marks

The Project work shall be of 40 marks and the distribution of marks will be as follows :

- | | | | |
|---|---------------------|---|----------|
| 1 | Project | : | 40 marks |
| 2 | Internal Assessment | : | 10 mark |

50 marks

69
M.Sc. (Zoology)
Semester - IV
Paper - XV

General Physiology (Elective Paper – III)

- Unit-I Physiology Nervous System
- 1.1 Functional compartmentalization of brain
 - a) Fore brain
 - b) Mid brain
 - c) Hind brain
 - 1.2 Reflex arc and types of reflexes
 - 1.3 Physiology and pharmacology of ANS
 - 1.4 Physiology of sleep : slow wave, Rapid eye movement physiological changes during sleep, sleep and ECG. Neurotransmitters involve in sleep. Wake fullness, sleep producing substances mechanism of sleep.
- Unit-II
- 2.1 Physiology of learning
 - 2.2 Mimicry: Cryptic mimicry Concealing mimicry Depressive mimicry
 - 2.3 Audio signals , Echo-location: Organs and physiology
 - 2.4 Bioluminescence: Mechanism of Bioluminescence. Significance of Bioluminescence.
 - 2.5 Bioelectricity
- Unit-III Homeostasis Physiology
- 3.1 Water contents and distribution
 - 3.2 Composition of ECF (Extra cellular fluid) and ICF (Intra cellular fluid)
 - 3.3 Abnormal water and electrolyte metabolism and water intoxication
 - 3.4 Maintenance of pH.
 - 3.5 Components of Homeostatic Control system. Reflexes, Local Homeostatic Responses
 - 3.6 Intercellular chemical messengers - Paracrine and Autocrine agents. Process related to Homeostasis.
- Unit-IV
- 4.1 Adaptation and Acclimatization. Biological Rhythms.
 - 4.2 Balance in the Homeostasis of chemicals.
 - 4.3 Homeostatic control systems - feed back.
 - 4.4 Basic thermoregulatory mechanism in poikilotherms and Endotherms.
Ectothermic adaptations to extreme temperature. Mechanism of heat production of lizards. Endothermic adaptations to extreme temperature. Control of body temperature in endotherms

- 70
- 4.5 Basic osmoregulatory mechanism in stenohaline and euryhaline species. Fresh water Marine water Terrestrial environment.

- Unit - V
- 5.1 Patterns of Nitrogen excretion among different animal groups.
 - 5.2 Mechanism of calcium and phosphate Homeostasis.
 - 5.3 Liver is important in the storage and Homeostasis of Iron.
 - 5.4 Factors destabilizing homeostasis mechanism fever, diabetes mellitus and diarrhea.
 - 5.5 Homeostatic mechanism of minerals.
 - 5.6 Homeostasis and antidiuretic hormone.

M. Sc. (Zoology)
Semester - IV
Paper - XVI

ELECTIVE PAPER IV (GENERAL PHYSIOLOGY)

Total Marks : 50

- Unit - I **Physiology of Digestion**
- 1.1. Gastro intestinal tract
 - 1.2 Digestion, Absorption, Utilization of Protein, Carbohydrate and Lipid
 - 1.3 Neural and endocrine regulation of gastro intestinal movements and secretions.
- Unit- II **Physiology of Respiration**
- 2.1 Anatomical and physiological organization of respiratory system.
 - 2.2 Mechanism of respiration breathing movements and the exchange of respiration, Respiratory gases at pulmonary surface.
 - 2.3 Transport of gases by blood.
 - 2.4 Vital capacity and partial pressure of gases, Oxygen dissociation curve, CO₂ dissociation curve.
 - 2.5 Respiratory center and Neuro Hormonal and Chemical regulation of respiration.
 - 2.6 Carbonic anhydrase, Chloride shift.
 - 2.7 Acidosis, Alkalosis, Asphyxia, Anoxia and Cyanosis.
- Unit- III **Physiology of Circulation**
- 3.1 Blood components and their functions
 - 3.2 Blood groups
 - 3.3 Plasma proteins
 - 3.4 Haematopoiesis
 - 3.5 Erythropoiesis

- 3.6 Cascade of biochemical reactions involved in coagulation of blood.
- 3.7 Platelets in clotting.
- 3.7 Leukocytes and its role in host defense.
- Unit- IV 4.1 Anatomy of mammalian heart
- 4.2 Structure & function of Myogenic and neurogenic heart
- 4.3 Cardiac out put
- 4.4 Cardiac cycle, Cardiac sound
- 4.5 Pace Maker system specialized conducting fibers
- Unit - V 5.1 Blood pressure and Electro cardiograph.
- 5.2 Lymph- composition, Formation
- 5.3 Functions of lymph
- 5.4 Structure and functions of lymph nodes.

Reading Material

- 1 Baileys:Text book of Histology
- 2 Bell Davidson: Text book of physiology and Biochemistry
- 3 Bolander F.F.: Molecular endocrinology
- 4 Clerk E.E. C.: Isolation and identification of Drugs in pharmaceutical of body fluid and post martical Vol.ISII.
- 5 Cole S. W.: The practical physiological chemistry.
- 6 Cooper: Poisoning by drugs and chemicals.
- 7 Eckert, Marsall: Animal physiology mechanism and Adaptations &
- 8 Eckert & Ranadak: Animal physiology (CBS)2nd ED (1978)
- 9 Garden M.S.: Animal physiology principal and Adaptations.
- 10 Hara & Oserburg; An introduction to crimminalistie.
- 11 Hill R.W.: Comparative physiology of animals
- 12 HoarW.S.: General and comparative physiology.
- 13 Houssa: Human physiology (McGraw Hill Books Compny)
- 14 Hunter& Bornford: Hutchisons Clinical methods
- 15 Hynes: The Biology of polluted water.
- 16 Jacobs M. B.: The analytic toxicology of inorganic poison
- 17 Keil J.B.,Samson Wrightsa, : Applied Physiology
- 18 Heil E. Joets N.: Physiology (Oxford Uni press) (1982)
- 19 Klein L: River pollution, causes& effects
- 20 Madhu Raj: Environmental Management of toxic and hazardous chemicals
- 21 Mill peter J.: Comparative neurobiology(EdHrbord London
- 22 Modi N.J.: Text Book of toxicology
- 23 Mitchell P.H.: Text Book of General physiology.
- 24 NormanA.W.: Hormones.

- 25 Odum: Fundamental of ecology.
- 26 Osterbong: The crime laboratory
- 27 Philips G.: Environmental physiology.
- 28 ProsserC.L.: Comparative animal physiology.
- 29 Ramkumar: Environmental Biodegradation.
- 30 Ramkumar: Environmental Chemical hazards.
- 31 Robert & Cosselin:First & emergency treatment and clinical toxicology of commercial product.
- 32 Seinfield J.J.: Air pollution(A,P.)
- 33 Smith ptterson: Text Book of physiology (ELBS) Read & Scratched (1988) llth Ed..
- 34 Sern A.C.: Air pollution (A.P.)
- 35 Stewart& stratman: Toxicology mechanism and analytical methods
- 36 Theils: Clinical Toxicology.
- 37 Tomb: An introduction to invertebrate endocrinology (Academic press)
- 38 West Best &Taylor,s: Physiological Basis of medical practice.
- 39 White R. Steions.: Pesticides in environment Vol.1
- 40 Wilsom J. A.: Principles of animal physiology.
- 41 Wod Densus W.: Principles of animal physiology.(Ed.ArboD) Lond

M.SC.ZOOLOGY SEMESTER-II

Project Work :

The subject of the project will be given to a student independently on any topic belonging to Life sciences. The examinee shall be required to produce three typed copies of project signed by teacher in-charge and certified by the department as bonafide work of him/her. Oral presentation is necessary to explain details there of the project. Therefore, he/she is required to prepare transparencies for O.H. P. or slides for slide projector, or power point program for L. C. D. projector if available. The *viva voce* on the project shall be the part of interaction among the examiner and the student presenting his/her project. Valuation and marks will be submitted to the university.

Distribution of marks –

1. Project submission	_____	40
2. (Internal assessment)	_____	10
Total :	_____	50 marks

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