

M.Sc. (Semester I to IV) Examinations in Zoology

List of papers.

M.Sc. I Semester I

- Paper-I Animal Structure and Function (Non-Chordata)
- Paper- II Animal Structure and Function (Chordata)
- Paper- III Gamete Biology
- Paper- IV Genes and Differentiation

M.Sc. I Semester II

- Paper- V Molecular Cell Biology
- Paper- VI Tools and Techniques in Biology
- Paper- VII Endocrinology
- Paper- VIII Ecology and Environment (Also GIC)

M.Sc. II Semester III

- Paper- IX Molecular Cytogenetic- I
- Paper- X Molecular Cytogenetic- II
- Paper- XI (Elective paper I) Molecular Biology - I
- Paper- XII (Elective paper-II) Molecular Biology - II
- Paper- XI (Elective paper I); Entomology: Paper-I Insect Classification And Morphology
- Paper- XII (Elective paper II) Entomology: Paper-II Insect Anatomy And Physiology
- Paper- XI (Elective paper I) (Animal Physiology-I)
- Paper- XII (Elective paper II) (Animal Physiology-II)
- Paper- XI (Elective paper I) Fisheries-I Fish Nutrition, Capture and Culture Fishery, Fisheries
- Paper-I XII (Elective paper II) Fisheries-II Fish Physiology

M.Sc.II Semester IV

- Paper- XIII (Compulsory) Biochemistry
- Paper- XIV (Compulsory) Enzymology and Biostatistics
- Paper- XV (Elective paper III) Molecular Biology - III (Molecular Immunology-1)
- Paper- XVI (Elective paper-IV) Molecular Biology - IV (Molecular Immunology -II)
- Paper- XV (Elective paper III); Entomology: III Developmental and Commercial Entomology
- Paper- XVI (Elective paper IV) Entomology: IV. Insect pests and pest control
- Paper- XV (Elective paper III) (Animal Physiology-III)
- Paper- XVI (Elective paper IV) (Animal Physiology-IV)
- Paper- XV (Elective paper III) Fisheries-III Fish Harvest and Post Harvest Technology
- Paper- XVI (Elective paper IV) Fisheries-IV, Fish Reproductive physiology and pathology

M.Sc.I (Zoology).

Semester I

Paper I

ANIMAL STRUCTURE AND FUNCTION (NON-CHORDATA)

- Unit I :** 1.1. Definition and basic concepts of biosystematics taxonomy and classification,
1.1. 1. History of Classification,
1.1.2. Trends in biosystematics: Chemotaxonomy cytotaxonomy and molecular taxonomy,
1.2. Dimensions of speciation and taxonomic characters.
1.3. Species concepts: species category, different species concepts, subspecies and other infra-specific categories.
1.4. Parsimony method of classification, cladistic method of classification, difference in the application of phenetic and cladistic classification; phylogram and cladogram

- Unit II :** 2.1. Feeding and Digestion:
2.1.1 Nutrition in protozoa –
2.2. Types and mode of feeding.
2.2.1 Feeding diversity in insects,
2.2.2 Functional mechanism of Filter feeding in Crustacean and Mollusca-
2.2.3 Feeding & digestion in Bryozoans and Echinodermata
2.3. Movements:
2.3.1 Micro morphology and mechanism of Movements of cilia and flagella
2.3.2 Hydrostatic evasive movements in Ctenophores and hydrostatic selection in annelids.
2.3.3 Insect flight mechanism.

- Unit III:** 3.1. Organs of respiration:
3.1.1. Body surface,
3.1.2. Gills,
3.1.3. Book-lungs
3.1.4. Tracheal system.
3.2. Respiratory pigments in invertebrates.
3.2.1. Mechanisms of gill respiration in Mollusca
3.2.2. Tracheal respiration in Arthropoda (Insecta).
3.3. Excretory organs and excretion:
3.3.1. Excretion in Protozoa.
3.3.2. Excretory structures and functions in Helminthes,
3.3.3. Excretory structures and functions in Annelids
3.3.4 Malpighian tubules structure and functions in Insects

- Unit IV:** 4.1. General organization of Nervous system

- 4.1.1. Coelenterata
- 4.1.2. Annelida,
- 4.1.3. Arthropoda (Crustaceans and Insects),
- 4.1.4. Mollusca (Cephalopod)
- 4.1.5. Echinodermata.

4.2. Sense organs:

- 4.2.1 Chemical senses & animal orientations in Nonchordates
- 4.2.2. Mechanoreceptor in Nonchordates,
- 4.2.3 Chemoreception & chemotaxis in insects
- 4.2.4 Photoreception and photosensitivity in non chordate forms,
- 4.2.5 Functional Morphology of compound eye in Insects

Unit V : 5.1. Reproductive mechanisms in Nonchordates.

- 5.1.1. Asexual, Sexual. Parthenogenesis, Hermaphroditism,

5.2. Functional variations of reproductive structures in non-chordate:

- 5.2.1. Porifera, Coelenterate. And Echinodermata

5.3. Invertebrate hormones of reproduction:

- 5.3.1. Annelids,
- 5.3.2. Mollusca,
- 5.3.3. Arthropods

5.4. Larval forms in Porifera, Coelenterata, helminthes, Annelida, Crustaceans.

5.5. Metamorphosis and molting in insects & its hormonal control

M.Sc.I (Zoology) Semester - I

Paper II

ANIMAL STRUCTURE AND FUNCTION (CHORDATA)

Unit I : 1.1. Taxonomic Character- Different kinds.

- 1.2. Origin of reproductive isolation,
- 1.3. Biological mechanism of genetic incompatibility.

1.4. Taxonomic procedures:

- 1.4.1. Taxonomic collections preservation curation,
- 1.4.2. Process of identification.

1.5. Taxonomic keys, different types of keys, their merits and demerits.

1.6 International code of Zoological Nomenclature (ICZN):

- 1.6.1. Operative principles, interpretation and application of important

rules:

1.7 Formation of Scientific names of various Taxa.

1.8 Taxonomic categories

Unit II : 2.1. Vertebrate integument.

- 2.1.1. General structure of mammalian skin.

2.1.2. Derivatives of skin,

2.1.3 Functions of skin.

2.2. Endoskeleton structures:

- 2.2.1. Endoskeleton in Protochordata,
- 2.2.2. Visceral skeleton in Fishes.
- 2.2.3. Jaw suspensorium in vertebrates,
- 2.3. Structure of tooth and dentition in Mammalia
- 2.4. Structural and functional organization of digestive system in Protochordata,
- 2.5. Structural and functional organization of Alimentary canal and digestive glands in vertebrates, with reference to Mammalian type.

- Unit III:**
- 3.1. Characteristics of Respiratory surface;
 - 3.2. Gills in fishes and mechanisms of gill respiration,
 - 3.3. Accessory respiration organs in fishes,
 - 3.4. Functional organization of Mammalian lungs,
 - 3.4.1. Exchange of gases.
 - 3.4.2. Aerodynamic of lungs,
 - 3.5. Larynx and Vocalization.
 - 3.6. Blood:
 - 3.6.1. Composition and functions,
 - 3.6.2. Haemopoiesis,
 - 3.7. Lymph and lymphatic system:

- Unit IV:**
- 4.1. Excretion:
 - 4.1.1 Excretory products,
 - 4.1.2 General nature of kidneys;
 - 4.1.3 Kidney structure in relation to Osmoregulation;
 - 4.1.4. Archinephros, Pronephros, Mesonephros, Metanephros:
 - 4.1.5. External salt excretion,
 - 4.1.6. Osmoregulation in freshwater and marine water fishes;
 - 4.2. Functional organization of vertebrate nervous system:
 - 4.2.1. Brain and spinal cord
 - 4.3. Sense organs:
 - 4.3.1. Organs of olfaction and taste.
 - 4.3.2. Organs of hearing and balance.

- Unit V :**
- 5.1. Echolocation;
 - 5.1.1. Morphological adaptation for echolocation
 - 5.1. 2. Bat Echolocation
 - 5.2. Lateral line system in fishes.
 - 5.3. Electroreception.
 - 5.4. Flight adaptations in mammals
 - 5.5. Aquatic adaptations in mammals.
 - 5.6. Adaptive radiations in mammals
 - 5.7. Migration in birds, and fishes;

Suggested Reading Material For paper - I and Paper - II- (All recent editions)

1. Hyman, L.H. The invertebrates. Vol. I. 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 Winstoin 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.
48. Boolotian and Stiles: College Zoology (Macmillan)
49. Campbell: Biology (Benjamin)
50. Marshall and Williams: Text Book of Zoology
51. Wolfe: Biology the Foundations (Wadsworth)
52. Wilson. Biodiversity, Academic Press, Washington.
53. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company
54. E. Mayer. Elements of Taxonomy.
55. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
56. Tirpathi, R. S. Biosystematic and taxonomy

Practical - I (Based on paper I and II)

A) Dissections:-

- i) Comparative anatomy of Excretion in Annelid, Insect and Molluscan models.
- ii) Poison gland of Ant/Spider
- iii) Nervous system:- Crab; Sepia/Loligo Squilla/Prawn, Earth worm
- iv) Digestive, Arterial systems and Cranial nerves of Scoliodon/ locally available fish, Internal ear of Scoliodon.)
- v) Digestive, Reproductive, portal Systems and Neck nerves of rat/ mouse

B) Mounting:-

- i) Nephridium, .Ovary and spermatathecata of Earthworm.
- ii) Mounting of mouth parts of mosquito-identification of genera & sex,

- iii) Halteres in housefly, Trachea of Cockroach,
- iv) Gill-lamella, Osphradium of Pila,
- v) Statocyst of Prawn, spicules of Herdmania, Velum of *Amphioxus*, Ampulla of Lorenzini from Scoliodon, fish scales.

C) **Qualitative and Quantitative** estimation of Zooplankton communities.

D) **Museum Study**:-Taxonomy of animal specimens/charts available in the laboratory representing different orders of Nonchordata, Protochordata, and vertebrata.

E) **Permanent stained preparations:**

Larval forms : Planula, Redia, Cercaria, Cysticercus, bladder worm, Trochophore, Nauplius, Zoea, Mysis, Phyllosoma, Antilon, Veliger, Bipinnaria, *Ophio* and Echinopluteus, Auricularia, Tornaria.

Mammalian Histology; Skin, bone, regions of alimentary canal, digestive glands, trachea, lung, kidney. Spinal cord, gonads, Endocrine glands.

F) **Comparative Osteology** (Excluding loose bones of skull):

Amphibia, Reptilia; Aves, mammals.

One long study tour, preferably at the sea-shore for study, collection and Observations of selected 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. 15 permanent stained micro- preparations prepared by the examinee.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources.

Distribution of Marks for practical - I

1) Major Dissection	20 marks
2) Minor dissection	15 marks
3) Identification and comments on spots (Specimens, slides, bones)	20 marks
4) Stained permanent preparations	10 marks
5) Submission of stained permanent preparations	10 marks
6) Practical record	10 marks
7) <i>Viva voce</i>	15 marks

Total **100 marks**

M.Sc.I (Zoology).

Semester - I

PAPER-III

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 and regulation

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

Unit II : 2.1 Ovarian follicular growth and differentiation

2.1.1 Morphology

2.1.2 Endocrinology

2.1.3 Molecular Biology

2.2 Oogenesis and vitellogenesis-morphogen gradient

2.3 Ovulation and its regulation

2.4 Fertilization

2.4.1 Cell surface molecules in sperm-egg recognition in animals

2.4.2 Reaction of sperm (Sperm motility, Capacitation, Chemotaxis, acrosome reaction, Fusion of sperm and egg plasmalemma)

2.4.3 Reaction of egg (formation of fertilization cone, Prevention of polyspermy)

2.5 Amphimixis

Unit III : 3.1 Creating multicellularity

3.1.2 Characteristics of cleavage divisions

3.1.3 Cleavage types

3.1.4 Gastrulation & formation of germ layers in animals

3.1.5 Embryogenesis

3.2. Genomic imprinting

Unit IV : 4.0 Assisted reproduction techniques

4.1 *In vitro* fertilization

4.2 Multiple ovulation/super ovulations

4.3 Collection and cryopreservation of gametes

4.4 *In vitro* gamete maturation

4.5 Embryo sexing Y specific probes

4.6 Screening of genetic disorders

4.7. ICSI and GIFT

4.8 Cloning of animals by embryo transfer

4.9 Disadvantages of ART

Unit V : 5.1 Transgenic animals

5.1.1. Procedure

5.1.2. Applications

5.2. Gene Knockout technology

- 5.2.1 Procedure
- 5.2.2 Applications
- 5.3. Gene therapies
 - 5.3.1 *Ex vivo* gene therapy
 - 5.3.2 *In vivo* gene therapy
 - 5.3.3 Antigens and antisense therapy

M.Sc.I (Zoology)

Semester - I

Paper IV

GENES AND DIFFERENTIATION

Unit.I : 1.0 Cell specification and Differentiation

- 1.1 Types of Cell specification
- 1.2 Cell commitment and differentiation
- 1.3 Characteristics of differentiation
- 1.4 Germ cell determination in nematodes, insects and 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 Axes and pattern formation in *Drosophila*, Amphibia and chick;
- 2.2 Establishment of body axes in mammals and birds.
- 2.3 Proximate tissue interactions (instructive and permissive)
- 2.4 Homeobox concept in different phylogenetic groups

Unit-III : 3.1 Environmental cues and effects

- 3.1.1 Malformation and disruption – Teratogenic effects of xenobiotics
- 3.1.2 Changing evolution through development modularity
- 3.1.3 Developmental constraints.
- 3.1.4 Creating new cell types –basic evolutionary mystery
- 3.2 Contraception:**
 - 3.2.1 Surgical methods
 - 3.2.2 Hormonal methods
 - 3.2.3 Physical barriers
 - 3.2.4 Intrauterine contraceptive devices (IUCDs)
 - 3.2.5 Immunocontraception: . Gamete specific antigens: Zona pellucida antibody, Sperm antibody

Unit-IV : 4.1 Biology of sex determination

- 4.1.1 Chromosomal and genetic basis of sex determination in mammals and *Drosophila*
- 4.1.2 Differentiation of gonads
- 4.1.3 Secondary sex determination in mammals
- 4.1.4 Environmental sex determination
- 4.2 Regeneration**

4.3 Connective tissue cell family

Unit V : 5.0 Stem cells

5.1 Properties of Stem Cells

5.2 The Embryonic Stem Cell

5.3 The Adult Stem Cell

5.4 Hematopoietic Stem Cells

5.5 Cord-blood stem cells and stem cell bank

5.6 Stem cell markers

5.7 Stem cell disorders: Aplastic anemia, Fanconi anemia, Paroxysmal nocturnal hemoglobinuria, Congenital cytopenia, Hirschsprung's disease

5.8 Stem Cells and Diabetes

5.9 Rebuilding the Nervous System with Stem Cells

5.10 Use of Genetically Modified Stem Cells in Experimental Gene

Therapies

5.11 Bone marrow transplantation

Suggested Reading Materials: All recent editions:

1. Long J.A. Evan H.M. 1922 : the oestrous cycle in the Rat and its associated phenomenon.
2. Nalbandou. A.C. - Reproductive physiology
3. Prakash A.S. 1965-66 Marshall's, Physiology Reproduction (3 Vol.)
4. Gilbert, S.F. Developmental Biology , Sinauer Associated Inc. Massachusetts.
5. Ethan Bier, the cold Spring. The cold spring Harbor laboratory Press, New York.
6. Balinsky B.I. Introduction to Embryology sanders, Phliedelphia.
7. Berril N.J. and Karp. G. Development Biology. McGraw Hill New York.
8. Davidson, E.H. Gene Activity During Early Development. Academic Press, New York.
9. Wolpert Principles of Development-
10. Slack Essential Developmental Biology- .
11. Principles of Development, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford University Press.
12. An Introduction to Embryology, 5th edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd
13. Developmental Biology, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD.
14. Concepts of Genetics, 9th edition (2008), William S. Klug, Michael R. Cummings, Charlotte Spencer, and Michael A. Palladino, Publisher-Benjamin Cummings
15. Genes IX, 9th edition (2008), Benjamin Lewin, Publisher-Jones and Barlett Publishers Inc.
16. Principles of Genetics, 4th edition, (2006), Snustad D. Peter and Simmons J. Micheal, Publisher -John Wiley and Sons. Inc.
17. Genetics, (1999), Daniel J. Fairbanks, W. Ralph Andersen Publisher-Brooks/Cole Pub Co.

18. Principles of Genetics, 8th edition (1991), Eldon J. Gardner, D.P. Snustad, M.J. Simmons, and D. Peter Snustad Publisher-John Wiley and Sons. Inc.
19. Microbial Genetics, (1987), David Freifelder, Publisher-Jones & Bartlett
20. General Genetics, (1985), Leon A. Snyder, David Freifelder, Daniel L. Hartl Publisher- Jones and Bartlett.
21. Genetics, 3rd edition, Monroe W. Strickberger, (1968), Publisher - Macmillan Publishing Co.

PRACTICALS- 2, based on Paper - III and - IV

1. Morphology and histology of non-chordate and chordate ovary and testis (Insects, snails, frog and rat)
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 parasitic larvae in *Limnea/Bellamia*
7. Study of development of *Amphioxus*, Frog, Chick and pig through slides and whole mounts
8. Effect of anti-fertility drugs on biochemical estimation in various part of reproductive tract
 - a) Ascorbic acid
 - b) Acid/Alkaline phosphatase
9. Morphogenesis and growth study of chick development
10. 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.
 - Amoxicillin
 - diclophenac sodium
 - paracetamol
 - Penicillin
 - Ibuprofen
16. Bio-assay of LH by OAAD test
17. Bioassay of estrogen using uterotrophic vaginal response or Analysis of ovarian / adrenal lipids by TLC
18. Protein synthesis as a prerequisite for E2-induced initiation of estrous cycle.
19. Oocyte maturation in fish using germinal vesicle breakdown test by the induction of maturation-inducing steroid
20. Determination of the stages of spermatogenesis in rat testis by PAS Haematoxyline technique. or Cyclic changes in the exfoliate cytology of vaginal Epithelium in rat.
21. Examination and submission of slide testis, ovary, epididymis, prostate and uterus And seminal vesicles

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.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources

Distribution of Marks

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

1. Mounting: Chick embryo / any Mollusca or parasitic larvae / Developmental stages/ stages of spermatogenesis.	:	
15.marks		
2. Identification of spots	:	20marks
3. Estimation / histological preparation/ Bioassay.	:	20marks
4. Sperm/ semen Examination/ slide of bone marrow;	:	20marks
5. Practical record	:	10 marks
6. <i>Viva voce</i>		15. Marks
-		-----
	Total	100 marks
-		-----

M.Sc. I (Zoology)
Semester - II
PAPER - V
MOLECULAR CELL BIOLOGY

Unit - I : 1.1 Biomembranes:

- 1.1.1 Biochemical Composition of biomembranes
- 1.1.2 Transport across cell membrane & transporters.
- 1.1.3 Membrane potential.
- 1.1.4 Transport across epithelia.

1.2. Extracellular matrix:

- 1.2.1 Basement membrane, basal lamina structural components, cross-linking Components.
- 1.2.2 Collagens & other proteins of extracellular matrix.
- 1.2.3 Cell-cell adhesion molecules.
- 1.2.4 Cell-matrix adhesion.
- 1.2.5 Gap junctions and connexins

Unit - II : 2.0 Cell Surface Receptors.

- 2.1 Modes of cell signaling (autocrine, juxtacrine, paracrine and endocrine)
- 2.2 Signaling molecules.
- 2.3 Properties of cell surface receptors.
- 2.4 G protein-coupled receptors that activate or inhibit adenylyl cyclase.
- 2.5 G protein-coupled receptors that regulate ion channels.
- 2.6 G protein-coupled receptors that activate phospholipase C.
- 2.7 Receptor protein-Tyrosine kinases
- 2.8 Receptor protein-Tyrosine phosphatases
- 2.9 Receptor protein-guanylyl cyclases
- 2.10 Receptor protein-serine/threonine kinase
- 2.11 Cytokine receptors

Unit III : 3.0. Cell Signaling:

- 3.1. Pathways of Intracellular signal transduction:
 - 3.1.1. Features of signal transducing systems,
 - 3.1.2. Second messengers,
 - 3.1.3 Ion channels and electrical signaling,
 - 3.1.4. Signal transduction by G Protein-coupled receptors,
 - 3.1.5. Signal transduction by receptor enzymes,
 - 3.1.6. JAK-STAT pathway,
 - 3.1.7. Smad pathway, Wnt pathway, Hedgehog pathway,
 - 3.1.8. Signal Transduction in vision, Gustation and Olfaction,

Unit IV: 4.1 Cell cycle control

- 4.1.1. Cyclins & cyclin dependent kinases (CDKs), Role of MPF
- 4.1.2. DNA replication block & its removal.
- 4.1.3. Cell cycle checkpoints & feedback control.

- 4.1.4. Regulation of CDK-Cyclin Activity
- 4.1.5. Programmed cell death (Apoptosis) - Definition, mechanism & significance

4.2. Cytoskeleton

- 4.2.1. Microfilaments & microtubules-structure and dynamics
- 4.2.2. Microfilaments membrane binding proteins & their function.
- 4.2.3. Intermediate filaments & their functions
- 4.2.4 Role of microtubules in mitosis.

Unit V : 5.0 Secretory pathways:

- 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. I (Zoology)

Semester - II

PAPER - VI:

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

Unit II : 2.1. Microscopes; Principles and application:

- 2.1.1. Light, phase contrast, fluorescence,
- 2.1.2. Scanning and transmission electron microscopy,
- 2.1.3. Atomic Force microscopy

2.2 Microbiological techniques

- 2.2.1. Media preparation and sterilization.
- 2.2.2. Inoculation and growth monitoring.
- 2.2.3. Use of fermenters.
- 2.2.4. Biochemical mutants and their use.
- 2.2.5. Microbial assays.

Unit III :

- 3.1. Organelle separation by centrifugation
 - 3.1.1 Cell separation by density gradient centrifugation,
 - 3.1.2. Cell separation by Unit gravity centrifugation,
 - 3.1.3. Cell separation by Affinity adsorption,
 - 3.1.4. Cell separation by anchorage based techniques

- 3.2. Design and functioning of tissue culture laboratory.
- 3.3. Cell culture techniques- Monolayer and Polylayer
- 3.4. Cell proliferation measurements.
- 3.5. Cell viability testing.
- 3.6. Culture media preparation and cell harvesting methods.
- 3.7. Tissue engineering

- Unit IV :**
- 4.1. Cryotechniques;
 - 4.1.1 Cryopreservation for cells, tissue, organisms.
 - 4.1.2. Cryotechniques for microscopy.
 - 4.1.3. Freeze-drying for physiologically active substances.
 - 4.2. **Separation techniques in biology.**
 - 4.2.1. Molecular separation by thin layer chromatography,
 - 4.2.2. Molecular separation by gas chromatography,
 - 4.2.3. Molecular separation by high pressure liquid chromatography,
 - 4.2.4. Molecular separation by ion exchange and affinity chromatography,
 - 4.2.5. Molecular separation by 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. (All recent editions)

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

Practical-3 based on papers V and VI

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 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.
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.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources

Distribution of Marks for Practical - III

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

1. Histochemical Cytological / demonstration. : 25marks
2. Experiment - I organelles Separation/
Microbiological Preparation : 25marks
3. Experiment -II (Chromatography/ electrophoresis) :25 marks

4. Class record : 10. marks
5. *Viva voce* : 15.marks

Total : 100 marks

MSc. I-Zoology

Semester-II

PAPER VII - ENDOCRINOLOGY

- Unit -I :**
- 1.1 Histology of vertebrate endocrine glands: Pituitary gland, Thyroid gland, Parathyroid gland, Adrenal gland, Pineal and Thymus gland
 - 1.2 Melatonin function: Jet-lag and sleep disturbances. Melatonin as an anti-oxidant. Melatonin and cancer. Melatonin and depressive disorders. Melatonin and endocrine disorders. Adverse effects of Melatonin.
 - 1.3 Histophysiology of endocrine placenta, testis and ovary in vertebrates
 - 1.4 Structure and functions of Islets of Langerhans
 - 1.5 Histophysiology of Uropharynx and Corpuscles of Stannius in fishes
- Unit - II :**
- 2.1 Classification of Hormones (Peptides, Steroids and amino acid derived)
 - 2.2 Hormone action at cellular level
 - 2.3 Hormone action at genetic level
 - 2.4 Hormones in biological clock
 - 2.5 Role of hormones in digestion
 - 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
 - 3.4 Prostaglandins
 - 3.5 Ectohormones in insects and mammals
- Unit -IV :**
- 4.1 Thyroid hormones and disorders
 - 4.2 Parathyroid hormones and disorders
 - 4.3 Pituitary hormones and major Disorders
 - 4.4 Adrenal Gland hormones and 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: Rennin, angiotensin, cytokines, 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.I : Zoology
Semester - II
PAPER VIII
ENVIRONMENT AND ECOLOGY

- Unit-I :**
- 1.1. The Environment:
 - 1.1.1 Physical environment;
 - 1.1.2 Biotic environment;
 - 1.1.3 Biotic and abiotic interactions.
 - 1.2. Habitat and niche:
 - 1.2.1 Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
 - 1.3. 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, Diversity Index: Simpson's index, Shannon's index
 - 1.4. Species interactions: Types of interactions, interspecific competition, herbivore, carnivores, pollination, symbiosis.

- Unit II :**
- 2.1. Community ecology:
 - 2.1.1. Nature of communities; community structure and attributes;
 - 2.1.2. Levels of species diversity and its measurements;
 - 2.1.3. Edges and ecotones.
 - 2.2. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.
 - 2.3. Ecosystem:
 - 2.3.1 Structure and function; energy flow and mineral cycling (CNP);
 - 2.3.2. Primary production and decomposition;
 - 2.3.3. Structure and function of some Indian ecosystems;
 - 2.3.3.1. Terrestrial (forest, grassland) .
 - 2.3.3.2. Aquatic (fresh water, marine, estuarine).
 - 2.4. Biogeography:
 - 2.4.1. Major terrestrial biomes;
 - 2.4.2. Theory of island biogeography;

2.4.3. Elementary idea of, biogeographical zones of India.

Unit III: 3.1. Environmental Pollution-

3.1.1. Sources nature and effects of air pollutants

3.1.2. Sources nature and effects of Water pollution

3.1.3 Biodegradation and bioremediation

3.1.4 Biotechnological methods for Management of pollution

3.2. Global climate change; Global warming, Global dimming,

3.3 Biodiversity-statuses;

3.3.1. Monitoring and documentation;

3.3.2. Major drivers of biodiversity change;

3.3.3. Biodiversity management approaches,

3.3.4. Economics of Biodiversity

Unit-IV : **4.1 Conservation biology:**

4.1.1. Principles of conservation; major approaches to management,
Indian case studies on conservation/management strategy:

4.1.2. Sanctuaries and National Parks,

4.1.3. Project Tiger,

4.1.4. Biosphere reserves.

4.2 Toxicology

4.2.1. Metabolism & effects of Organochlorine, organophosphate and carbamate pesticides

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

4.2.3. Metabolism & effects of heavy metal salts.

4.2.4. Formation & effects of free radicals.

4.2.5. Biochemistry of Detoxification – Phase I & phase II reactions.

Unit -V: 5.1 Environmental Monitoring:

5.1.1- IGPC (Inter Government Policy/ Protocol for Climate change)

5.1.2- EPA (Environmental Protection Agency)

5.1.3- Laws, legislation pertaining to environment

5.1.4- Control, monitoring & surveillance of environment.

5.1.5- IPR (Intellectual Property Rights) ; Patents need how to obtain in India & abroad, patent offices in India.

5.2. Environmental Impact Assessment Processes:

5.2.1. EIA of reservoirs and Coal mines, thermal Power stations

Suggested reading materials: (All recent editions)

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. Animal Physiology, mechanism & Adaptation - Eckert, Marshall
7. Animal Physiology, Principal & Adaptation- Garden M. S.
8. Human Physiology- C. C. Chatterji Vol. I and II
9. Analytical toxicology of inorganic poisons - Jacob M.B
10. Environmental management of toxic and hazardous chemical -Madhuraj
11. Environmental Biology - J. L. Blish
12. Fundamental Ecology - Odum
13. Environmental Physiology - Philips G.
14. Toxicology mechanism & analytical methods - Stewarts & Stratman
15. Environmental Impact Assessment: G.N.Vankhede Biotech Publishers, Delhi
16. Ecology and Biogeography of India, Mani, M.S. : 1974. Junk. Publ. The Hague.
17. Comparative Vertebrate Endocrinology, Bentley: Cambridge University Press, 1998
18. Fundamentals of Comparative Endocrinology, Chester-Jones et al.: Plenum Press,
19. New York, London, 1987.
20. Comparative Endocrinology, Gorbman et al.: John Wiley & Sons, New York, 1983
21. Vertebrate Endocrinology, Norris: (2nd ed.), Lea & Febiger, 1997.
22. Vertebrate Endocrinology Schreibman & Pang: Vol. I-IV, Fundamentals & Biomedical Implications, Academic Press, 1985 & onwards
23. Endocrinology, Hadley: Prentice hall. International Edition. 2000
24. Essentials of Endocrinology, Brooks and Marshall Blackwell Science. 1995
25. General Endocrinology, Turner and Bagnara: W. B. Saunders Company Philadelphia. 1984
26. Text Book of Endocrinology, 10th edition Larson: Williams. W. B. Saunders Company, Philadelphia. 2002.
27. William's text book of Endocrinology. (XI edition) H. M. Kronenberg, S. Melmed,
28. K.S. Polonsky and P. R. Larsen. Publisher - Saunders, Elsevier Inc. (2009).

Practical -4 Based on paper VII and VIII:

1. To study the rate of oxygen consumption by aquatic animals under various Environmental stress.
2. Anatomy and Histology of various vertebrates endocrine glands and insects neuroendocrine structures.
3. Effect of toxicants on histoarchitecture of various endocrine glands.
4. To study changes of blood glucose level under various environmental stress
5. Determination of respiratory quotient of an air breathing animal at different Temperatures.
6. Study of toxicity of given chemical to analyze its activity histologically.
7. Study of toxicity of given chemical on various blood and tissue biochemical.
8. To estimate total hardness of different samples of water.
9. To estimate nitrate contents of different samples of water.
10. Diversity indices from soil and aquatic fauna.

11. Determination of LC50 / LD50 and 95% Confidence limit of any Toxicant to a selected aquatic/ terrestrial organism.
12. Effects of toxicants on blood parameters of fish.
13. Sensitivity test during early life (embryonic) stages.
14. Instrumentation AAS/ HPLC for residue analyses of toxicant
15. Biodiversity Inventories/Surveys. and Field Techniques.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources

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:

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

1. Histological preparation	25 marks
2. Experiment I (estimation)	25 marks
3. Experiment II (Toxicology) ...	25 marks
4. Class record	10. Marks
5 <i>viva voce</i>	15 marks
Total.....	
	100 marks