

संत गाडगे बाबा अमरावती विद्यापीठ

SANT GADGE BABA AMRAVATI UNIVERSITY

विज्ञान विद्याशाखा
(FACULTY OF SCIENCE)

अभ्यासक्रमिका

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(प्राणिशास्त्र)

PROSPECTUS
OF
MASTER OF SCIENCE IN
ZOOLOGY
Semester -I, Winter 2012
Semester-II, Summer-2013
Semester -III, Winter 2013
Semester-IV, Summer-2014



2012

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7 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

8. 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)

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Paper- IX	Molecular Cytogenetic- I
Paper- X	Molecular Cytogenetic- II
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Paper- XII	(Elective paper-II) Molecular Biology – II
Paper- XI	(Elective paper I); Entomology: Paper-I Insect Classification And Morphology
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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

10. 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 –I1)
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

SANT GADGE BABA AMRAVATI UNIVERSITY

Syllabus prescribed for 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

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Paper- XVI	(Elective paper IV) Fisheries-IV, Fish Reproductive physiology and pathology

Syllabus prescribed for 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. IVEd. 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. Wolstenholnf, 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
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 spermatathea of Earthworm.
- ii) Mounting of mouth parts of mosquito-identification of genera & sex,
- iii) Halters 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
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M.Sc.I (Zoology).

Semester - I

PAPER-III

GAMETEBIOLOGY

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**

3.1.1 Characteristics of cleavage divisions

3.1.2 Cleavage types

3.1.4 Gastrulation & formation of germ layers in animals

3.1.4 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, Philadelphia.
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
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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

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 Polylyer
- 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. <i>Viva voce</i> | : 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 Urophypophysis and Corpuscles of Staninus 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

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, interdemec 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 Schreiber & 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
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M.Sc. II(ZOOLOGY) SEMESTER III

Paper – IX

MOLECULAR CYTOGENETICS-I

Unit-I : 1.0 Mutation:

- 1.1 Basic features of mutation
- 1.2 Adaptation versus mutation
- 1.3 Phenotypic Effects of mutation
- 1.4 **Molecular basis of gene mutation:**
 - 1.4.1 Mutations induced by chemicals, radiation .
 - 1.4.2 Mutations caused by the DNA replication machinery

- 1.4.3 Hot spots of mutation
- 1.4.4 Detection of mutagens -The Ames Test
- 1.4.5 DNA repair mechanisms
- 1.4.6 Diseases resulting from defects in DNA repair mechanisms

Unit-II : 2.1 Somatic Cell Genetics:

- 2.1.1 Agents and mechanism of cell fusion
- 2.1.2 Heterokaryon – selection of hybrids and chromosome segregation
- 2.1.3 Radiation hybrid panels and gene mapping

2.2 Epigenetics:

- 2.2.1 Mechanisms of DNA Methylation
- 2.2.2 Methyl-CpG Recognition
- 2.2.3 Demethylation in Mammals
- 2.2.4 Mechanisms of Histone modifications
- 2.2.5 Prions and Epigenetic Inheritance
- 2.2.6 Polycomb Mechanisms and Epigenetic Control of Gene Activity

Unit-III : 3.0 Genome Organization:

- 3.1 Hierarchy in genome organization
- 3.2 Mobile DNA

3.2 Genetics of Cancer:

- 3.2.1 Properties of cancer cells
- 3.2.2 Benign and malignant tumors
- 3.2.3 Metastasis
- 3.2.4 Relationship of cell cycle to cancer
- 3.2.5 Oncogenes
- 3.2.6 Tumor suppressor genes

Unit-IV : 4.1 Human Cytogenetic:

- 4.1.1 Human karyotypes - banding - nomenclature
- 4.1.2 Dosage compensation
- 4.1.3 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, Achondroplasia

4.4 Other Genetic Diseases: Sickle cell anemia, Hemophilia, Thalassemia, Cystic Fibrosis, Huntington disease, Alzheimer's disease, Parkinson's disease

Unit-V : 5.1 Mitochondrial DNA and human diseases:

- 5.1.1. Structure of mitochondrial DNA,
- 5.1.2. Leber's Hereditary Optic Neuropathy (LHON),
- 5.1.3. Myoclonic Epilepsy and Ragged Red Fiber Disease (MERRF),
- 5.1.4. Pearson Marrow-Pancreas Syndrome (PMPS),
- 5.1.5. Kearns-Sayre Syndrome,
- 5.1.6. Mitochondrial Neurogastrointestinal Encephalomyopathy (MNGIE),
- 5.1.7. Sensorineural Hearing Loss

5.2 Genetic Counseling:

- 5.2.1. Carrier detection,
- 5.2.2. Fetal analysis (amniocentesis and chorionic villus sampling),
- 5.2.3. Pedigree analysis

MSc. II. (Zoology) Semester III

Paper – X

MOLECULAR CYTOGENETICS- II

Unit-I : 1.1 Microbial genetics:

- 1.1.1. Bacterial chromosome,
- 1.1.2. Bacterial transformation, and conjugation,

- 1.1.3. Generalized transduction and specialized transduction.

1.2 Bacteriophages:

- 1.2.1. Types of bacteriophages,
- 1.2.2. Structure of T4 phage and morphogenesis

1.3. Extra chromosomal inheritance:

- 1.3.1. Inheritance of mitochondrial genes,
- 1.3.2. Maternal inheritance of kappa particles in *Paramecium* and shell coiling in *Limnaea*.

Unit-III': 1.1 Drosophila Genetics:

- 1.1.1. Introduction to *Drosophila* genetics, advantages of *Drosophila* as a model organism for genetic studies

1.2 Polytene chromosomes:

- 1.2.1. Polytenisation process, significance, bands, interbands, puffs, regulation of puffing activity, ecdysone puffs, induction of puffs by stress.

1.3. Behavioral traits.

- 1.3.1. Mutants, tools and Methodologies for genetic analysis,
- 1.3.2. Genetic and molecular basis of behavioral traits in *Drosophila*

Unit-III : 3.1. Molecular Cytogenetic Techniques:

- 3.1.1. DNA fingerprinting: Principle, procedure and applications
- 3.1.2. Flow cytometry
- 3.1.3. Chromosome painting
- 3.1.4. DNA sequencing: Sanger's dideoxy method, Automated DNA sequencing, Maxam and Gilbert's chemical degradation method.
- 3.1.5. Polymerase chain reaction (PCR)
- 3.1.6. Fluorescence *in situ* hybridization (FISH)

3.2. Genome Analysis :

- 3.2.1. Detailed account of genome models of lambda phage, *E. coli*, *C. elegans*, *Drosophila* and human.

3.3. Functional genomics

Unit-IV : 4.1 Population Genetics:

- 4.1.1 Genetic variation in natural populations, phenotypic variation, Polymorphism of Chromosome structure, Variation at molecular level
- 4.1.2 Hardy-Weinberg principle of genetic equilibrium, Genetic drift, Gene pool
- 4.1.3 Ecological significance of molecular variations

4.2. Genetics of quantitative traits in populations:

- 4.2.1 Molecular analysis of quantitative traits
- 4.2.2 Genotype-environmental interactions
- 4.2.3 Inbreeding depression and heterosis

Unit-V : 5.0 Molecular Phylogenetic:

- 5.1 Methods of phylogenetic tree reconstruction
- 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 Mitochondrial DNA and evolution.

Practical-5 for Paper – IX and X (Molecular Cytogenetic)

- 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 of 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 karyotypes 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. Genetic disorders,
- 15) Study of mtDNA disorders through Photographic slides

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

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 bona fide work of the examinees.

Distribution of Marks:

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

1. Estimation / Experiment	: 30 marks
2. Cytological Preparation	: 25 marks
3. Problems on Genetics (any two)	: 20 marks
Total	: 100 marks
4. Class Record	: 10 marks
5. <i>Viva Voce</i>	: 15 marks

Total : 100 marks

Suggested Readings:- (All recent editions)

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
14. Tollefsbol T. Handbook of Epigenetics : The New Molecular and Medical Genetics. Academic Press.

MSc. II (Zoology) Semester III:

Paper-XI (Elective paper-I)

MOLECULAR BIOLOGY – I

- Unit-I** :
- 1.1 Scope of Molecular Biology
 - 1.2. DNA replication:
 - 1.2.1 Prokaryotic DNA replication
 - 1.2.2 Eukaryotic DNA replication
 - 1.3 Prokaryotic and Eukaryotic transcription:
 - 1.3.1 RNA polymerases - structure and function
 - 1.3.2 General and specific transcription factors
 - 1.3.3 Regulatory elements
 - 1.3.4 Mechanism of prokaryotic transcription
 - 1.3.5 Mechanism of eukaryotic transcription
 - 1.3.6 Transcription regulation in eukaryotes
 - 1.3.7 Transcription regulation in prokaryotes: Lac, Trp, Gal and Ara operons
 - 1.3.8 Transcriptional and post-transcriptional gene silencing.

- Unit-II** :
- 2.1 Co- and Post-transcriptional modifications in mRNA
 - 2.1.1 5'-cap formation
 - 2.1.2 Transcription termination
 - 2.1.3 3'- end processing and polyadenylation
 - 2.1.4 Splicing
 - 2.1.5 Editing
 - 2.1.6 Nuclear export of mRNA
 - 2.1.7 mRNA stability
 - 2.2 Translation:
 - 2.2.1 Genetic code.
 - 2.2.2 Prokaryotic and eukaryotic translation.
 - 2.2.3 Polyribosome formation.
 - 2.2.4 Regulation of translation.
- Unit-III** :
- 3.1 Antisense and Ribozyme Technology:
 - 3.1.1 Molecular mechanisms of antisense molecules.
 - 3.1.2 Inhibition of splicing, polyadenylation and translation.
 - 3.1.3 Disruption of RNA structure and capping.
 - 3.1.4 Biochemistry of ribozyme: hammerhead, hairpin and other Ribozymes.
 - 3.1.5 Strategies for designing ribozymes.
 - 3.1.6 Applications of antisense and ribozyme technologies.
 - 3.2 Fluorescent proteins:
 - 3.2.1 General properties,
 - 3.2.2 Properties and Modifications of *Aequorea victoria* Green Fluorescent Protein Green Fluorescent Proteins, Yellow Fluorescent Proteins, Blue and Cyan Fluorescent Proteins, Red Fluorescent Proteins
 - 3.2.3 Fluorescent Protein Vectors and Gene Transfer
 - 3.2.4 Mutations that improve Fluorescent proteins as imaging probes,
 - 3.2.5 Applications of Fluorescent proteins

- Unit-IV** : 4.0 Protein engineering
 4.1 Rational of protein engineering
 4.2 Basic assumptions of protein engineering
 4.3 Steps involved in protein engineering
 4.4 Methods for protein engineering
 4.5 Chemical modifications of enzymes
 4.2 Protein Biochips:
 4.2.1 Technological Aspects: Protein Immobilization and Surface Chemistry, Transfer and Detection of Proteins, Chip Content
 4.2.2 Applications of Protein Biochips
- Unit-V** : 5.0 Drug designing
 5.1 Target Discovery: Disease Mechanism, Disease Genes, Target Type and 'Drugability', Functional Genomics
 5.2 Target Validation: Pathways, Clinical Data, Antisense DNA/RNA and RNAi, Chemical Knock-out and Chemical Biology
 5.3 Assay Development: *In vitro*/Cell-based *In vivo*/Animal Models, HTS
 5.4 Screening & Hits to Lead : Compound Libraries, *in silico*/CADD and SBDD, Synthesis and Combinatorial Chemistry, Primary Screen, Potency and Dose-response, Counterscreens and Selectivity, Mechanism of Action (MOA)
 5.5 Lead optimization: Medicinal Chemistry, Animal PK/PD/ADME, Toxicity, Formulation and Delivery
 5.6 Development: Pre-clinical Data Package, Process Development/CMC/API, IND Application
 5.7 Clinical Trials: Phase I, Phase II and Phase III

M.Sc.II.(Zoology), Semester III:

Paper- XII (Elective paper-II)

MOLECULAR BIOLOGY – 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** : 4.1 Selection of transformants using antibiotic resistant genes,
 4.2 genetic markers, and hybridization,
 4.3 probe preparation-radioactive and nonradioactive probes,
 4.4 strategies used in hybridization-colony, plaque, northern and western blots, dot blot and slot blot hybridization, Eastern blotting, South-western blotting.
- Unit V** : 5.1 RNA interference:
 5.1.1 Cellular mechanisms: dsRNA cleavage, MicroRNA, RISC activation and catalysis, Transcriptional silencing, Crosstalk with RNA editing
 5.1.2 Significance of interfering RNA: Protection against viral infections, genome stability, immune defence, regulation of the development of organisms, chromatin condensation and suppression of transcription, gene therapy.

5.2 Applications of genetic engineering in agriculture, Pharmacy, medicine, gene therapy, industries, environmental pollution.

5.3 PCR - Principles, methodology, modifications, applications.

Suggested Reading Materials: (All recent editions)

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 – Verlog, New York
4. Resnekov, O. & A.V. Gabain (Editors) "*Post – Transcriptional Control of Gene Expression*" Springer – Verlog, 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.*
10. *Molecular Biology of the Gene. James D. Watson, Michael Levine, Richard Losick, Bell, Baker Latest edition / Pub. Date: December 2003 Publisher: Benjamin Cummings.*
11. *Molecular Biotechnology: Principles and Applications of Recombinant DNA. Bernard R. R. Glick, Jack J. Pasternak. Latest edition / Pub. Date: July 2002. Publisher: ASM Press.*
12. *Genes VIII. Benjamin Lewin. Latest edition / Pub. Date: December 2003. Publisher: Prentice Hall.*
13. *DNA Microarrays: A Molecular Cloning Manual. David Bowtell (Editor), Joseph Sambrook (Editor). Latest edition / Pub. Date: September 2002. Publisher: Cold Spring Harbor Laboratory Press.*

Practical -6. Based on Paper XI and XII (Molecular Biology – I & II)

Practical -III

1. DNA fingerprinting.
2. Extraction of DNA from bacteria.
3. Extraction of DNA from yeast.

4. Extraction of DNA from animal tissue.
5. Extraction of DNA from whole blood.
6. Determination of molecular size of DNA.
7. Restriction digestion and determination of molecular weights of different DNA fragments by running a standard marker.
8. Demonstration of plasmids in the gel by gel electrophoresis.
9. Isolation and cleaning the DNA fragment of interest from the agarose gel.
10. DNA transformation into bacterial cells.
11. Separation of immunological proteins (alpha, beta, gamma) by paper or gel Electrophoresis.
12. Screening of antigen and antibody (screening test in antibody production (Ouchterlony Double Diffusion).
13. Estimation of antigen and antibody content in the samples by quantitative Precipitation assay.
14. Estimation of antigen and antibody content in the samples by Radial Immunodiffusion.
15. Counter - current immunoelectrophoresis.
16. Dot ELISA.
17. Separation of immunological proteins (alpha, beta, gamma) by paper or gel electrophoresis.

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

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 bona fide work of the examinees.

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

Distribution of Marks

1. DNA Electrophoresis based experiment	: 25 marks
2. DNA Extraction based experiment	: 25 marks
3. Immunology based Experiment	: 25 marks
4. Certified Practical record book	: 10 marks
5. <i>Viva voce</i>	: 15 marks

Total : 100 marks

Syllabus prescribed for M.Sc. II (Zoology) Semester IV**Paper – XI****(Elective paper: Entomology -I)****INSECT CLASSIFICATION AND MORPHOLOGY**

- UNIT I** : 1. Major Classification of Class Insect
- 1.1 Distinguishing Characters, general biology, habits and habitats of Insect Orders and economically important families contained in them.
- 1.1.1 Apterygota,
- 1.1.2 Pterygota,
- 1.1.2.1 Division Palaeoptera –
- 1.1.2.2 Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders: Subdivision: Hemipteroid Orders (=Paraneoptera):
- UNIT II** : 2. Distinguishing characters, general biology, habits and habitats of Insect Orders and economically important families contained in them (Continued).
- 2.1 Subdivision Endopterygota,
- 2.1.1 Section Neuropteroid- Coleopteroid Orders,;
- 2.1.2 Section Panorpid Orders and Section Hymenopteroid Orders
- UNIT III** : 3.1 Principles, utility and relevance: insect body wall structure,
- 3.2 Special integumentary structures in insects.
- 3.3 Head- Origin, structure and modification;
- 3.4 Types of mouthparts and antennae,
- 3.5 Tentorium and neck sclerites.
- UNIT IV** : 4.1 Thorax-
- 4.1.1 Areas and sutures of tergum, sternum and pleuron, pterothorax;
- 4.2 Wings:
- 4.2.1 Structure and modifications, venation, wing coupling apparatus .
- 4.2.2 Mechanism of flight; Legs: structure and modifications.

- UNIT V** : 5.1 Abdomen- Segmentation and appendages;
- 5.2 Genitalia and their modifications;
- 5.3 Morphology of Insect sense organs (mechano-, photo- and chemoreceptor).

M.Sc. II (Zoology) Semester IV Paper – XII**(Elective paper: Entomology -II****INSECT ANATOMY AND PHYSIOLOGY**

- UNIT I** : 1.1 Structure, modification and physiology of digestive systems.
- 1.2 Structure, modification and physiology of, Circulatory systems
- UNIT II** : 2.1 Structure, modification and physiology of respiratory systems-,
- 2.2 Structure, modification and physiology of excretory systems;
- 2.3 Osmoregulation, water Conservation mechanisms
- UNIT III** : 3.1 Structure, modification and physiology of nervous systems-
- 3.2 Transmission of nerve impulses, neurotransmitters and modulators.
- 3.3 Physiology of sensory systems
- 3.4 Production of receptor potentials in different types of sensilla
- UNIT IV** : 4.1 Structure, modification and physiology of reproductive systems-,
- 4.2 Structure, modification and physiology of endocrine and exocrine glands.
- UNIT V** : 5.1 Physiology of insect growth and development-
- 5.2 Metamorphosis, polyphenism and diapause.
- 5.3 Physiology and biochemistry of insect cuticle and moulting process.

Practical -6 based on elective (Entomology) papers XI and XII:

1. Study of Orders of insects and their identification using taxonomic keys.
2. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera.
3. Field visits to collect insects of different orders.
4. Study of insect segmentation, various tagmata and their appendages;
5. Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia.
6. Sense organs.
7. Dissection of different insects to study comparative anatomical details of
8. different systems;
9. Preparation of permanent mounts of internal systems;
10. Chromatographic analysis of free amino acids of haemolymph;
11. Determination of chitin in insect cuticle;
12. Examination and counting of insect haemocytes;
13. Determination of respiratory quotient;
14. Preparation and evaluation of various diets;
15. Consumption, utilization and digestion of natural and artificial diets.
 - 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.
 - Separation of haemolymph proteins by electrophoresis.
 - Estimation of Na⁺ & K⁺ in haemolymph by flame photometer.
 - Estimation of DNA and RNA in Haemocytes/tissues.

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

Suggested Reading Materials: (All recent editions)

1. Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.
2. David BV & Ananthkrishnan TN. 2004. *General and Applied Entomology*.
3. Tata-McGraw Hill, New Delhi.
4. Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.
5. Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., New Delhi.
6. Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall, London.
7. Saxena RC & Srivastava RC. 2007. *Entomology: At a Glance*. Agrotech Publ. Academy, Jodhpur.
8. Snodgrass RE. 1993. *Principles of Insect Morphology*. Cornell Univ. Press, Ithaca.
9. Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.
10. Kerkut GA & Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, New York.
11. Patnaik BD. 2002. *Physiology of Insects*. Dominant, New Delhi.
12. Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Vol. 1. *Structure, Physiology and Development*. Chapman & Hall, New York.
13. Saxena RC & Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Jodhpur.
14. Wigglesworth VB. 1984. *Insect Physiology*. 8th Ed. Chapman & Hall, New York.
15. Kerkut GA & Gilbert LI. 1985. *Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, Oxford, New York.
16. Muraleedharan K. 1997. *Recent Advances in Insect Endocrinology*. Assoc. for Advancement of Entomology, Trivandrum, Kerala.
17. CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers*. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.
18. Freeman S & Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.
19. Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall, London.

20. Ross HH.1974. *Biological Systematics*. Addison Wesley Publ. Co.
 21. Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects*. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

Note: Student should collect local insects and submit at the time of examination, 10 morphological and 10 histological slide preparations should also be submitted.

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

Distribution of Marks Full Marks: 100

1.	Dissection	
	a. Major.....	15
	b. Minor.....	10
2.	Physiological experiment.....	20
3.	Permanent stained preparation.....	10
4.	Identification of Morphological & Histological spots. (ten)	20
5.	Practical Record and Insect Collection	10
6.	Viva Voce	15
Total ...		100

M. Sc.II Zoology Semester- III

Paper - XI

Elective Paper - Animal Physiology -I

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, Trappe, 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 and Molecular basis of muscle contraction
- 1.9. Role of Ca⁺⁺, Calcium receptors, Calmodulin and calcium pump.

- Unit-II :**
- 2.1. Ultra Structure of neuromuscular junction (motor end plate) Synthesis and Release of acetylcholine, Events at the neuromuscular junction (chemical and Electrical) Presynaptic Events during muscle contraction. Action of acetylcholine on the end plate membrane, Destruction of the released acetylcholine
 - 2.2. Myasthenia gravis.
 - 2.3. Neuromuscular transmission influenced by toxins, drugs.
 - 2.4. Muscular disorders: Hypo tonicity, Hypertonicity, Fibrillation and Denervation Hypersensitivity.
 - 2.5. Red and White fibers and muscle function.

Unit-III : Nerve Physiology

- 3.1. Ultra structure 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. Ultra structure 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
- 4.9. Role of calcium, sodium and potassium channels
- 4.10. Types of neurotransmitters, their synthesis and storage (Epinephrine, nor epinephrine, 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. II (Zoology) Semester - III

Paper - XII

Elective Paper - Animal Physiology -II

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, Ultra filtration, Reabsorption, and Secretion, Significance of Henley's loop in production of hyper osmotic urine
- 3.3 Function of aldosterone, antidiuretic hormone and renninangiotensin system in renal physiology
- 3.4 Role of kidney in pH regulation and water salt regulation

Unit-IV :

- 4.1 Structure and mechanism of action of Hypothermic hormones (TRH, GnRH)
- 4.2 Control of Pituitary hormones by hypothalamus
- 4.3 Hormonal function of male
- 4.4 Hormonal function of female
- 4.5 Foetal Physiology
- 4.6 Neonatal Physiology

Unit V :

- 5.1 Introduction to Sociophysiology
- 5.2 Honey and lac productions in insects
- 5.3 Pheromones in insects
- 5.4 Pheromones in mammals
- 5.5 Physiology underlying fear and anxiety in animals
- 5.6 Physiology underlying parental care in Primates

Practical 6 based on Elective Paper - Animal Physiology I and II

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. Quantities 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. Cardio dynamics; 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.
 13. Estimation of genomic DNA in fish, reptiles, birds and mammals
 14. Agarose gel electrophoresis of DNA
 15. 3-D viewing of Acetylcholine, ion channel proteins using RasMol/ Deepview softwares.
 16. Molecule docking using freeware Argust lab software.

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

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

Distribution of marks for practical physiology

	Marks
1 Major physiology experiments.....	30
2 Minor physiology experiments.....	20
3 Experiment on blood.....	25
4 Class record.....	10
5 <i>Viva voce</i>	15
Total :	100 Marks

Suggested Reading Materials: (All recent editions): Provided with Papers XV and XVI

Paper- XI (Elective paper)

Fisheries-I

Fish Nutrition, Capture and Culture Fishery,

UNIT I : The Inland Capture Fishery resources of India (Freshwater)

1.1 Riverine fisheries

1.1.1 Different river System

- 1.1.2 Riverine fisheries resources
- 1.1.3 Regulation and exploitation
- 1.1.4 Improvement of fish stocks
- 1.1.5 River pollution
- 1.1.6 Dams and their effect on fish migration and remedial measures
- 1.2 Cold water fishery
 - 1.2.1 Cold water fisheries resources
 - 1.2.2 Fisheries management and Development in cold water.
- 1.3 Lacustrine fisheries resources
- 1.4 Estuarine fisheries
 - 1.4.1 Estuarine fisheries resources
 - 1.4.2 Problems confronting brackish-water capture fisheries.
- 2 Marine fishery
- 3 Marine fishery resources of India.

UNIT II : 2.1 Chemical composition and nutritional value of fish

2.1. Nutrition:

- 2.1.1 Physiological roles of nutrients
- 2.1.2 Food and feeding habits of freshwater fishes, prawn, mussel and oysters
- 2.1.3. Nutritional bio-energetics
- 2.1.4. Nutrient requirement (proteins, lipids, carbohydrates, minerals and vitamins) for various growth stages of freshwater carp, prawn and mussel
- 2.1.5 Conventional and non conventional feed sources
- 2.1.6 Presence of anti nutritional factors and their removal procedures.

2.2 Supplementary feed:

- 2.2.1 Kind of supplementary feeds
- 2.2.2 Composition and nutrient source
- 2.2.3 Feeding frequency
- 2.2.4 Formulation and processing of feeds

- 2.2.6 Storage and quality control of feeds
- 2.2.7 Feed dispensing methods
- 2.3 Live feed culture.

UNIT III : 1. Fish culture systems

1.1 Ponds

- 1.1.1 Fish farm : Construction and lay out of different types of ponds
- 1.1.2 Pond management: Nursery pond, Rearing Pond and Stocking pond
 - 1.1.2.1 Physico-chemical properties of pond water and soil and their maintenance
 - 1.1.2.2 Manuring (organic and inorganic) and liming
 - 1.1.2.3. Pond stocking and productivity
 - 1.1.2.4. Composite fish farming : Exotic fishes and their role in fish farming
 - 1.1.2.5 . Predatory and weed fishes and their eradication
 - 1.1.2.6. Aquatic insects and their control
 - 1.1.2.7. Aquatic vegetation and its control
 - 1.1.2.8. Biological means of increasing production

UNIT IV : 1.2 Cage

- 1.3 Rafts
- 1.4 Pens
- 1.5 Raceways
- 1.6 Recirculating water system
- 1.7 Sewage-fed fisheries
- 1.8. Fish culture in paddy fields
- 1.9. Culture of Larvicidal fishes- Guppy)
- 1.10.Types of hatcheries and their operation and management
- 2. Age and Growth
 - 2.1. Methods of age determination- scale reading, otolith and vertebrae reading
 - 2.1 Growth rate and aging
 - 2.2 Length weight relationship
 - 2.3 Gonadosomatic index

Unit V : 5. 1 Non-fin fisheries

- 5.1.1 Prawn fishery
- 5.1.2 Crab fishery
- 5.1.3 Lobster fishery
- 5.1.4 Molluscan fishery
- 5.1.5. Oyester fishery

5.2 Maintenance of Aquarium

- 5.2.1 Aquarium tools and accessories
- 5.2.2 Aquarium fish feed
- 5.2.3 Ornamental fishes

Paper- XII (Elective paper)

Fisheries-II

Fish Physiology

UNIT I : 1. Integument

1.1 Epidermis

- 1.1.1 Mucogenic
- 1.1.2 Keratinized epidermis

1.2 Dermis

- 1.2.1 General organization
- 1.2.2 Scales
- 1.2.3 Chromatophores

2. Respiration

2.1 Aquatic respiration

- 2.1.1 Gills
- 2.1.2. Mechanisms of respiration
 - 2.1.2.1 Counter current principle
 - 2.1.2.2 Water flow across the gills
 - 2.1.2.3 Respiratory pump
 - 2.1.2.4 Pump musculature and skeleton
 - 2.1.2.5 Gas exchange

2.2 Air-breathing

- 2.2.1 Accessory respiratory organs and respiratory epithelium
- 2.2.2 Physiological adaptation in air-breathing fishes

- 2.3 Transport of respiratory gases
 - 2.3.1 Transport of oxygen
 - 2.3.2 Transport of carbon dioxide

UNIT II : 2.1 Digestion

- 2.1.1. Alimentary canal and its modifications in relation to food and feeding habits
- 2.1.2. Digestive fluids and enzymes.
- 2.1.3. Digestion and absorption of lipid, protein and carbohydrate
- 2.1.4. Gastrointestinal motility control 1
- 2.2. General organization , structure and Functions of swim bladder

UNIT III : Circulation

- 5.1 Heart and aortic arches
- 5.2 Regulation of cardiac activity
- 5.3 Hemodynamics
- 5.4 Cardiac output
- 5.5 Circulation time
- 5.6 Blood pressure
- 5.7 Composition of blood, Fish haemoglobins and polymorphism.

UNIT IV:

- 1. Nervous system
 - 1.1 Brain and Cranial nerves
 - 1.2.1 Eye
 - 1.2.1.1 Structure
 - 1.2.1.2 Photoreceptive functions
 - 1.2.1.5 Functional adaptations
 - 1.2.2 Acoustico-lateralis system
 - 1.2.3 Chemoreceptors, . Gustatory receptors, Olfactory receptors
 - 1.2.4 Electroreceptors

UNIT V : 2. Excretion and osmoregulation

- 2.1 Glomerular and aglomerular kidneys
- 2.2 Excretion of nitrogenous wastes, water and ion balance
 - 2.2.1 Urea cycle
 - 2.2.2 Stenohaline teleosts
 - 2.2.3 Euryhaline teleosts
 - 2.2.4 Migratory teleosts

Practicals based on Paper- XI (Elective paper) Fisheries-I Fish Nutrition, Capture and Culture Fishery, Fisheries Paper- XII (Elective paper) Fisheries-II Fish Physiology

1. Experiments on Water Analysis

Estimation of Dissolved gases, Dissolved Oxygen, Free Carbon dioxide, Estimation of Dissolved Solids, Chlorides, Carbonate, Bicarbonate, Total Alkalinity, Total hardness, Nitrites, Nitrates, Ammonia, Phosphates, Estimation of Biological Oxygen Demand, Estimation of Chemical Oxygen Demand, Estimation of Primary productivity of any local pond, river, lake or reservoir.

2. Plankton Analysis

Collection, preservation and estimation of planktons, Quantitative analysis- Enumeration of Zooplanktons by i) drop count method ii) Sedgwick Rafter Cell method/ Preparation of Diversity indices, Population density, Determination of dominance of the species.

3. Collection, identification and classification of Locally available fishes, prawns, lobsters and mollusks of economic importance.
4. Collection and Identification of common aquatic insects/ aquatic weeds
5. Permanent micro preparation of different kinds of scales in fishes.
6. Dissection of locally available fishes: Accessory respiratory organs in *Clarias* and *Heteropneustes*, Digestive, Reproductive Nervous system Brain, Cranial nerves Pituitary, in carps, Nervous system in Prawn, Lobster, Crab.
7. Formulation and processing of feeds,
8. Collection and Identification of carp spawn and fry,
9. Construction and Maintenance of Aquarium
10. Preparation of models and designing of cages and pens Visit to Fish farm.
11. Fish pathology- Study of fish parasites and diseases, pathological experiments
12. Fish physiology experiments- Digestive enzymes, biochemical composition

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 :

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. Permanent stained micro- preparations prepared by the examinee.
3. Collection of the specimens
4. Study tour diary.

Distribution of Marks for practical - I

1)	Dissection:		
	a .Major....		15 marks
	b. Minor		10 marks
2)	Experiment based on, water analysis/Fish pathology	10 marks	
3)	Identification and comments on spots (05) (Fishes, Crustaceans, Aquatic Insects, Aquatic weeds, Zooplanktons)	20 marks	
4)	Permanent micro preparation	10 marks	
5)	Submission of Permanent slides and specimen collected	10 marks	
6)	Practical record	10 marks	
7)	Submission of study tour report	05 marks	
8)	<i>Viva voce</i>	10 marks	
Total :			100 marks

M.Sc. II (Zoology) Semester IV

Paper - XIII - Biochemistry (Compulsory)

- Unit - I :** 1.0. **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 : 2.0. **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 : 3.0 **Nucleic Acids**

- 3.1 Structure of DNA
- 3.2 Triplex and quadruplex DNA.
- 3.3 Structural polymorphism of DNA
- 3.4 Circular DNA and super coiling.
- 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 : 4.0. **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 : 5.0. **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 α -oxidation of fatty acids
- 5.4 β - and ω -oxidation of fatty acids.
- 5.5 Energetic of fatty acid oxidation
- 5.6 Role of carnitine shuttle
- 5.7 Ketone bodies – Structure, biosynthesis and functions

M.Sc.II (Zoology) 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 Diagrammatic representation of data (Line graph, Bar diagram, Pie diagram)
 - 4.2 Graphic representation of data (histogram, frequency polygon, frequency curve cumulative frequency)
 - 4.3 Confidence Intervals (CI)
 - 4.4 Standard deviation,
 - 4.5 Standard error,
 - 4.6 Significance test (student 't' test)- paired and unpaired
- Unit-V : 5.0. Biostatistics (continued)**
- 5.1 chi square test as a test for goodness of fit
 - 5.2 Analysis of variance (ANOVA)
 - 5.3 correlation analysis, correlation types and methods to study correlation, significance test of correlation coefficient
 - 5.4 Regression analysis, kinds of regression analysis (regression line, regression equations)
 - 5.5 Estimation of allele frequency (dominant and co-dominant cases)
 - 5.6 Examples on Hardy-Weinberg equilibrium

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. Statistical techniques in Bioassay Z.Govindarajulu (2000): Pub. S.Kargar
15. Statistical method in Bioassay Pub D.J.Finney (1971): Griffin
16. Laboratory manual for Biochemistry and Molecular biology, Shivnery Publishers R.N. Vankhede & S. N. Niwane
17. Probit analysis D.J.Finney (1971) :, 3rd edition Pub. Griffin

Practical -7

Based on papers XIII and XIV and elective paper XV and XVI (mentioned in the concern syllabi)

- 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.

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.

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

Distribution of Marks: Based on papers XIII and XIV and elective groups paper XV and XVI

1) Estimation /experiment:	30
2) From elective paper (Estimation / experiment / Dissection) :	20
3) Example / Experiment /slide / computer based practical :	25
4) Class Record, collection, slides (as per syllabus) :	10
5) <i>Viva-Voce</i> :	15
Total :	100

M.Sc. II.(Zoology) Semester IV

Paper – XV

(Elective paper: MOLECULAR BIOLOGY-III)

(Molecular Immunology –1)

Unit-I : 1.1 The immune system

- 1.1.1 Innate and Acquired immunity, Interrelationship between Innate and Acquired Immunity
- 1.1.2 Organization and structure of lymphoid organs
- 1.1.3 Cells of the immune system and their differentiation and functions
- 1.1.4 Lymphocyte traffic

1.2. Nature of antigens and immunogens

- 1.2.1 Antigenicity and immunogenicity
- 1.2.2 Requirements for Immunogenicity: Foreignness, High Molecular Weight, Chemical Complexity, Degradability
- 1.2.3 Epitopes, Haptens, Adjuvants
- 1.2.4 Superantigens

Unit-II : 2.0 Structure and Functions of antibodies:

- 2.1 Classes and subclasses
- 2.2 Structural Features of IgG: Structure of Light and Heavy Chains, Domains, Hinge Region, Variable Region, Immunoglobulin Variants, Isotypes, Allotypes, Idiotypes,
- 2.3 Biologic Properties of IgG
- 2.4 Structural Features of IgM, Biologic Properties of IgM
- 2.5 Structural Features of IgA, Biologic Properties of IgA
- 2.6 Structural Features of IgD, Biologic Properties of IgD
- 2.7 Structural Features of IgE, Biologic Properties of IgE
- 2.8 Antibody mediated effector functions
- 2.9 **Complement system:** Alternate, Classical and Lectin pathways, Late steps of complement activation, Structure and functions of MAC, Receptors for complement proteins, Regulation of complement activation, Functions of Complement system

Unit-III : 3.1 Biology of T - lymphocytes:

- 3.1 Isolation, molecular components and structure
 - 3.1.2 T-cell generation, maturation, activation, proliferation and differentiation
 - 3.1.3 T cell Receptor Complex
 - 3.1.4 T cell Co receptors
 - 3.1.5 Other Important Molecules expressed on the T cell Surface
- 3.1.6 Generation of T cell Receptor Diversity
- 3.1.7 T Cell death and T-cell population
- 3.1.8 Cell mediated effector functions
- 3.1.9 Signal Transduction by the TCR Complex

- 3.2.1 Intracellular signaling events during T cell activation
- 3.2.2 MAP kinase signaling pathways in T lymphocytes
- 3.2.3 Calcium and PKC-mediated signaling pathways in T lymphocytes
- 3.2.4 Activation of transcription factors that regulate T cell gene expression

Unit-IV : 4.1 Biology of B - lymphocytes:

- 4.1.1 B-cell generation, maturation, activation, proliferation and differentiation
- 4.1.2 B-cell receptors
- 4.1.3 Selection of immature self-reactive B-cells
- 4.1.4 T-B cell interactions
- 4.1.5 Humoral immune response
- 4.1.6 Signal Transduction by the BCR Complex
- 4.1.7 Role of complement in B cell activation
- 4.1.8. 0 Mechanisms of action of CTL and NK cells

4.2.0 Immunological memory**4.3 Immunologic tolerance****Unit-V : 5.1 Cytokines:**

- 5.1.1 General Properties of Cytokines
- 5.1.2 Cytokines that mediate and regulate innate immunity
- 5.1.3 Cytokines that mediate and regulate adaptive immunity
- 5.1.4 Cytokines that Stimulate Hematopoiesis,
- 5.1.5 Cytokine receptors and Cytokine Receptor-Mediated Signal Transduction
- 5.1.6 Role of Cytokines and Cytokine Receptors in Diseases

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

- 5.2.1 MHC haplotypes
- 5.2.2 Structure of Class I and Class II molecules
- 5.2.3 Peptide binding
- 5.2.4 Genomic organization of the MHC
- 5.2.5 Expression and diversity
- 5.2.6 Disease susceptibility and MHC/HLA

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

- Unit-I** : 1.1 *in vitro* Antigen-Antibody interactions
- 1.1.1 Characteristics of Antigen-antibody reactions
 - 1.1.2 Agglutination reactions
 - 1.1.3 Precipitation reactions: Fluid and Gel
 - 1.1.4 ELISA
 - 1.1.5 RIA
- 1.2. 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** : 2.1 Principles of Immunization
- 2.1.1 Active Immunization:
 - 2.1.2 Basic Mechanisms of Protection, Significance of the Primary and Secondary Responses, Age and Timings of Immunizations, Precautions, Site of Administration of Antigen, Hazards
 - 2.1.3 Vaccines:
 - Vaccines Produced by Recombinant DNA Technology, Conjugated Polysaccharide vaccines, Synthetic Peptide Vaccines, Anti-Idiotypic Vaccines, Virus-vector Vaccines, Bacterium-vector Vaccines, DNA Vaccines, Toxoids as vaccines, Edible vaccines, Immunorobot and nubot.
- 2.2. 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 Globulins
- 2.3 Autoimmunity and Diseases:
- 2.3.1 Antibody mediated autoimmune diseases
 - 2.3.2 T Cell mediated autoimmune diseases

- 2.1.3 Immune complex mediated autoimmune diseases
- 2.1.4 HLA linked immunological diseases
- 2.1.5 Pathogenesis of autoimmunity

- Unit-III** : 3.1 Hypersensitivity Reactions:
- 3.1.1 Hypersensitivity and immune response to infectious agents especially intracellular parasites
 - 3.1.2 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.
 - 3.1.3 Antibody Mediated (Type-II) 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.
 - 3.1.4 Type III Hypersensitivity: Systemic Immune Complex Diseases, Localized Immune Complex Diseases.
 - 3.1.5 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-IV** : 4.1 Immunodeficiency:
- 4.1.1 Immunodeficiency disorders : Acquired immunodeficiency syndrome - Origin of AIDS virus, Structure of HIV, Mechanism of infection, HIV-I genome, T_H cell specificity for HIV infection, Mechanism of destruction of T cells, Functional abnormalities of different cell types in AIDS patient, Development of AIDS vaccine.

- 4.2 Transplantation Immunology:
- 4.3 Immune Responses to Allografts: Recognition of Alloantigens, Activation of Alloreactive Lymphocytes
- 4.4 Effector Mechanisms of Allograft Rejection: Hyperacute Rejection, Acute Rejection, Graft Vasculopathy and Chronic Rejection
- 4.5 Xenogeneic Transplantation
- 4.6 Blood Transfusion
- 4.7 Bone Marrow Transplantation: Graft-Versus-Host Disease, Immunodeficiency after Bone Marrow Transplantation

Unit-V : 5.1 Tumor immunology:

- 5.1.1 Tumor Antigens:
 - Products of Mutated Genes, Abnormally Expressed Cellular Proteins, Antigens of Oncogenic Viruses, Oncofetal Antigens, Altered Glycolipid and Glycoprotein Antigens, Tissue-Specific Differentiation Antigens,
- 5.1.2 Immune Responses to Tumors: Innate Immune Responses to Tumors, Adaptive Immune Responses to Tumors
- 5.1.3 Evasion of Immune Responses by Tumors
- 5.1.4 Immunotherapy for Tumors: Stimulation of Active Host Immune Responses to Tumors, Passive Immunotherapy for Tumors with T Cells and Antibodies
- 5.1.5 The Role of the Immune System in Promoting Tumor Growth
- 5.2 Animal Cell Culture:
 - 5.2.1 Importance of Animal Cell Culture Technology
 - 5.2.1 Serum and Serum Free Culture Media
 - 5.2.3 Culturing and Sub-Culturing of Animal Cells, Monolayer culture techniques, Primary culture
 - 5.2.4 *In Vitro* Transformation of Animal Cells
 - 5.2.5 Measurement of growth and viability of cells in culture
 - 5.2.5 Cell Line Preservation
 - 5.2.6 Cell Line Characterization.

Practical to be carried out in practical No. 7

1. Identification of blood groups - A, B, AB, O and Rh
2. Estimation of total proteins.
3. Estimation of histone proteins.

Along with also carried out necessary experiments relevant to the syllabi depending on resources, and availability.

Suggested reading materials (All latest editions):

1. Basic Immunology: Abul K. Abbas, Andrew H. Lichtman. Latest edition, Publisher: Elsevier Health Sciences.
2. Immunology. David A. Goldsby, Janis Kubly, Thomas J. Kindt, Barbara A. Osborne Latest edition, Publisher: W. H. Freeman Company.
3. Immunology. Ivan Roitt, Jonathan Brostoff, David Male, David K. Male (Editor). Latest edition, Publisher: Elsevier Health Sciences.
4. Cellular Interactions and Immunobiology (Biotol S.) Latest edition. Publisher: ButterworthHeinemann.
5. Defence Mechanisms, Biotol Series, Butterworth/Heinemann, Oxford, UK.
6. HighYield Immunology. Arthur G. Johnson . Latest edition / Pub. Publisher: Lippincott Williams & Wilkins.
7. B Alberts *et al*, Essential Cell Biology: An Introduction to the Molecular Biology of the Cell. 2/e, 2003. ISBN 0-8153-3480-X (with CD-ROM). A short version of the Alberts book listed above.

M.Sc.II. (Zoology) Semester IV

Paper – XV

(Elective paper: Entomology -III)

DEVELOPMENTAL AND COMMERCIAL ENTOMOLOGY

- UNIT I** : 1.1 Types of immature stages in insect orders, morphology of egg, nymph/larva And pupa.
- 1.2 Types of metamorphosis.
- 1.3 Comparative study of life history strategies in hemimetabola and holometabola, immature stages.
- 1.4 Significance of immature stages for pest management.
- UNIT II** : 2. Bee keeping-
- 2.1 General colony management during different seasons. Seasonal management.

- 2.2 Managing colonies for honey production and pollination.
- 2.3 Artificial queen rearing.
- 2.4 Pests and diseases of honey bees.
- 2.5 Bee poisoning.
- 2.6 Production and marketing of quality honey and value added honey products.
- 2.7 Establishment and maintenance of apiaries.

UNIT III : Mulberry sericulture:

- 3.1 Cultivation of food plants.
- 3.2 Bioecology of mulberry silkworms.
- 3.3 Rearing of silkworms.
- 3.4 Harvesting and processing of cocoons
- 3.5 Reeling appliances
- 3.6 Diseases of *Bombyx mori*
- 3.7 Predators and parasitoids of silkworm and their management

UNIT IV : 4. Non-Mulberry sericulture:

- 4.1 Tasar sericulture: Cultivation of food plants , Bioecology and rearing of tasar silkworms Pupation and cocoon formation. Stifling and reeling of cocoons
- 4.2 Muga sericulture; Cultivation of food plants Bioecology and rearing of Muga silkworms Pupation and cocoon formation Grainage technology Stifling and reeling of cocoons
- 4.3 Eri sericulture: Cultivation of food plants, Bioecology and rearing of tasar silkworms, Pupation and cocoon formation Stifling and reeling of cocoons

UNIT V : 5.1 Lac culture:

- 5.1.1 Lac insect and its life history ,
- 5.1.2 Host plant management
- 5.1.3 Strains of lac insects, Propagation of lac insects, Lac crop management,
- 5.1.5 Natural enemies of lac insects and their management
- 5.1.6 Lac extraction,

- 5.2 Economic and public health importance of insect pests in human habitation and habitats: biology, damage and control of, mosquitoes, houseflies head and body lice, , cloth moths, crickets, wasps, house dust mites,
- 5.3 Insect pests of cattle, poultry, pet animals and their management.

M.Sc. II (Zoology) Semester IV

Paper – XVI

(Elective paper: Entomology -IV

INSECT PESTS AND PEST CONTROL

- UNIT I :** 1. Nature and extent of damage, seasonal abundance of followings:
- 1.1 Insect pests of cereals and millets
 - 1.2 Major Insect pests of pulses, tobacco, oilseeds..
 - 1.3 Major Insect pests of fiber crops, forages, sugarcane.
- UNIT II :** 2. Nature and extent of damage, seasonal abundance of followings:
- 2.1 Major pests of fruits crop:
 - 2.2 Major Insect pests of Fruit Crops-, mango, guava, banana citrus
 - 2.3 Major Insect pests of Vegetable crops- tomato,, brinjal, okra, all gourds, leafy vegetables etc.
 - 2.4 Major Insect pests of stored grain,
- UNIT III :** 3. Biological control.
- 3.1 History, principles and scope of biological control; important groups of Parasitoids, predators and pathogens;
 - 3.2 Principles of classical biological Control- importation, augmentation and conservation. Biology, adaptation, host seeking behaviour of predatory and parasitic Groups of insects.
 - 3.3 Role of insect pathogenic nematodes, viruses, bacteria, Fungi, protozoa etc., their mode of action.

- UNITIV :** 4.1 Modern trends in pest control: use of chemosterilants, radiation, hormones and pheromones.
- 4.2 Integrated pest management: Principle, modeling and application. Political, social and legal implications of IPM;
- 4.3 Pest risk analysis; pesticide risk analysis; case studies of successful IPM programmes.
- 4.4 Principles and methods of pest management in residential places and public Buildings,
- UNITV :** 5.1 Tools of pest management and their integration-legislative, cultural, physical and mechanical methods;
- 5.2 Classification of insecticides based on mode of entry, mode of action and chemical nature.
- 5.3 Structure and mode of action of Organochlorine, organophosphates, carbamates, pyrethroid, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbial, botanicals, new promising compounds, etc.

List of Practical: To be carried with the practical 7

1. Types of immature stages; their collection, rearing and preservation.
2. Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.
3. Identification of honey bee species, bee castes and special adaptations,
4. Identification and handling of bee-keeping equipments.
5. Dissections of honey bees/silk worm
6. Visit to bee nursery and commercial apiaries.
7. Silkworm rearing and management.
8. Dissections of larval and adult silk moths.
9. Lac host and crop management technology and processing of lac. Products and bye-products of lac.
10. Collection and identification of important pests and their natural Enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

11. Assessing pest status in dwellings (labs, canteen or hostel), implementation of pest control against flies, mosquitoes, bed bugs, cockroaches.
12. control of silverfishes in the library.
13. Visit to poultry units and assessing pest status in poultries..
14. Laboratory and field evaluation of bioefficacy of insecticides; Bioassay techniques; porbit analysis; evaluation of insecticide toxicity and joint action.
15. Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers.
16. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds.
17. Field collection of parasitoids and predators.
18. Hands-on training in culturing, identification of common insect pathogens.

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

Suggested reading materials (All latest editions):

1. Atwal AS. 2006. *The World of the Honey Bee*. Kalyani Publ., New Delhi.
2. Ganga G. 2003. *Comprehensive Sericulture*. Vol. II. *Silkworm Rearing and Silk Reeling*. Oxford & IBH, New Delhi.
3. Partiban S & David BV. 2007. *Management of Household Pests and Public Health Pests*. Namratha Publ., Chennai.
4. Singh S. 1975. *Beekeeping in India*. ICAR, New Delhi.
5. Aruga H. 1994. *Principles of Sericulture*. Oxford & IBH, New Delhi.
6. Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches*. Kalyani Publ., New Delhi.
7. Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.
8. Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management*. 1st Ed., Springer, New York.
9. Partiban S & David BV. 2007. *Management of Household Pests and Public Health Pests*. Namratha Publ., Chennai.
10. Atwal AS, Dhaliwal GS & David BV. 2001. *Elements of Economic Entomology*. Popular Book Depot, Chennai.

11. Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects*. Kalyani Publ., New Delhi
12. Evans JW. 2005. *Insect Pests and their Control*. Asiatic Publ., New Delhi.
13. Nair MRGK. 1986. *Insect and Mites of Crops in India*. ICAR, New Delhi.
14. Prakash I & Mathur RP. 1987. *Management of Rodent Pests*. ICAR, New Delhi.
15. Saxena RC & Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Jodhpur.

M. Sc.II (Zoology) Semester - IV

Paper - XV

Elective Paper - Animal Physiology –III

- Unit-I** : 1.0 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 (Intracellular 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 temperatures. Mechanism of heat production of loric. Endothermic Adaptations to extreme temperature. Control of body temperature in endotherme
 - 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. II (Zoology) Semester - IV

Paper - XVI

Elective Paper - Animal Physiology -IV

- Unit-I** : 1.1. Digestion, Absorption, Utilization of Protein, Carbohydrate and Lipid
- 1.2 Histophysiology of gastric gland
 - 1.3 Secretory Functions of the Alimentary Tract
 - 1.4 Gastrointestinal Function—Motility, Nervous Control

- 1.5. Gastrointestinal peptides
- 1.6 Gastrointestinal disorders (Achalasia, gastritis, pancreatitis and colitis,)
- 1.7 Evolution and role of leptin

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 Infectious respiratory diseases (SARS, Avian Flu and Swine flu)
- 2.8 Oxygen therapy

Unit-III : Physiology of Circulation

- 3.1. Anaemia and polycythemia, platelets and Blood substitute.
- 3.2 Regulation of heart beat and blood pressure
- 3.3 Circulatory and respiratory responses to extreme conditions
- 3.4 Blood pigments: Role in oxygen transport, Oxygen dissociation curves and their physiological significances, Transport of CO₂.
- 3.5 Origin and conduction of cardiac impulse
- 3.6 Myocardial infarction and cardio myopathy.

- Unit-IV :**
- 4.1 Anatomy and histology 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 its regulation, Factors that affects blood pressures.
 - 5.2 Electro cardiograph, and interpretations of ECG.
 - 5.3 Lymph- composition, Formation
 - 5.4 Functions of lymph
 - 5.5 Structure and functions of lymph nodes.

Practical To be carried with the practical 7: Based on Animal Physiology XV and XVI

1. Properties of saliva. Isolation and identification of rumen micro organisms.
2. Estimation of rumen ammonia and blood urea under various physiological conditions.
3. Normal and abnormal constituents of urine.
4. Microscopic examination of urine.
5. Prepararion 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. Seperation of protiens by paper and gel electrophores
9. Qualitative analysis of urea, ketone bodies and salts

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

Suggested Reading Materials(All latest editions)

- 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 Seinfeld 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. II (Zoology) Semester - IV
Paper- XV (Elective paper)
Fisheries-III Fish
Harvest and Post Harvest Technology

- UNIT I : National fishery Policy of India**
1. Inland fishing gears and fishing methods
 - 1.1 Biological factors in fishing
 - 1.2 Classification of fishing gears
 - 1.3 Natural and synthetic fibers and preparation of fishing nets
 - 1.4 Maintenance of nets
 - 1.5 Fishing crafts- Mechanised and non-mechanised boats
 - 1.6 Unconventional fishing methods- Electrofishing, light fishing , Echosounder and sonar
- UNITII : 2.1 Biochemical composition and nutritional value of fish.**
2. 2.1 Freshness of fish
 - 2.2 Fish decomposition- Post mortem changes and rigormortis, Causes of spoilage.
 - 2.3 Methods of fish preservation
 - 1.1 Refrigeration and freezing
 - 1.2 Drying
 - 3 Salting
 - 1.4 Smoking
 - 1.5 Canning,
 - 1.6 Pickling, pasting and spicing
 - 1.7 Fermentation
 - 1.8 Marinating
- UNIT-III : 3.0 Fishery by-products, their production and utilization**

- 3.1 Liver oils
 - 3.2 Body oils
 - 3.3 Fish meal
 - 3.4 Fish flour
 - 3.5 Fish silage
 - 3.6 Fish solubles
 - 3.7 Fish protein
 - 3.8 Fish guano
 - 3.9 Shark fins and fin rays.
 - 3.10 Fish roes
 - 3.11 Fish glue
 - 3.12 Isinglass
 - 3.13 Fish skin
 - 3.14 Chitin
 - 3.15 Chitosan
 - 3.17 Surgical suture from fish gut
 - 3.18 Pearl
 - 3.19 Fish manure
- UNITIV :**
- 4.1 Fisheries economics and marketing.
 - 4.1.1 Fish Marketing – definition and scope, functions of fish marketing, Markets and market structure,
 - 4.1.2 Types of market: wholesale, terminal, retail, and fairs. Functions: Selling, transportation, storage, gradation, money transaction.
 - 4.1.3 Marketing system: Use flows, physical flows and channel flows. Procedures: Sale proceed at- markets, production centre, head quarters, marketing (intradistrict and interstate).
 - 4.1.4 Strategy for fish market development. Price determination
- UNITV :**
- 5.1 Fisheries managements and extension.
 - 5.2 Government and Fishermen's Co-operative Societies, integration, marketing efficiency, marketing cost and price spread, marketing planning,
 - 5.3 Survey of Fishery Resources.
 - 5.4 Concept of Exclusive Economic Zone (EEZ), Maximum Sustainable Yield (MSY), Maximum

- Economic Yield (MEY), Optimum Sustainable yield (OSY), Fish Farmers Developmental Agencies.
- 5.5 Institutional Support to fisheries, Crop Insurance

M. Sc. II (Zoology) Semester - IV

Paper- XVI (Elective paper)

Fisheries-IV

Fish Reproductive physiology and pathology

- UNITI :**
- 1.1 Functional morphology of gonads of teleost.
 - 1.1.1 Gametogenesis
 - 1.1.2 Gonadal steroidgenesis and its control
 - 1.2. Reproductive behaviour and pheromones
 - 1.3. Types and mode of reproduction
 - 1.4 Secondary sexual characters
 - 1.5 Sexuality ,Intersex ,Bisexuality, Hermaphroditism
 - 1.6 Parental care.
- UNITII :**
- 2.1 Cryo-preservation of gametes and embryo (gene banking)
 - 2.2 Fecundity, Survival and Mortality in fishes
 - 2.3 Induced breeding
 - 2.4 Factors affecting spawning
 - 2.5 Hypophysation
 - 2.6 Use of different synthetic and natural hormones, their formulation and Mechanism of action
 - 2.7 Bundh Breeding
- UNITIII :**
- 3.1. In vitro fertilization and incubation
 - 3.2. Fish seed collection from natural resources
 - 3.3. Identification and differentiation of eggs and hatchlings of
 - 3.4 Indian Major carps & common cat fish.
 - 3.5 Development of fish up to hatchlings Fish and Fish seed transport,
 - 3.6 Fundamentals of fish genetics
 - 3.7 Fish Biotechnology.
 - 3.8 Gynogenesis Androgenesis Polyploidy Production of monosex population Hybridization
 - 3.9 Transgenic fishes

- UNITIV :** 4. Endocrinology
- 4.1 Hypothalamo-hypophyseal system
 - 4.2 Functional morphology of pituitary
 - 4.3 Hypothalamic control of pituitary
 - 4.4.7 Structure and functions of the Pineal
 - 4.4.1 Structure and functions of the Thyroid, Ultimobranchials, Pancreas
 - 4.4.4 Structure and functions of the Adrenal Corpuscles of Stannius Urophysis

- UNITV :** 5.0 Fish Pathology, prophylaxis and therapy
- 5.1 Protozoan diseases of fish
 - 5.2 Helminth diseases of fish
 - 5.3 Crustacean parasites of fish
 - 5.4 Fungal diseases of fish
 - 5.5 Bacterial diseases of fish
 - 5.6 Viral diseases of fish
 - 5.7 Nonparasitic diseases

Practicals to be carried out along with practical VII, Based on – Paper- XV (Elective paper) Fisheries-III Fish Harvest and Post Harvest Technology Paper- XVI (Elective paper) Fisheries-IV Fish Reproductive physiology and pathology

1. Study of gonadal development in carps and other cultivable finfishes
2. Induced breeding of fishes through various inducing agents
3. Evaluation of carp milt and egg.
4. Collection and Identification of carp spawn and fry
5. Determination of age of fish by scale reading.
6. Study of length weight relationship in fish.
7. Morphometric study of given fish.
8. Exercises on Hardy-Weinberg equation.
9. Isolation of DNA from fish blood
10. Collection, identification and isolation of live food organisms using various techniques
11. Preparation of various culture media
12. Mass culture of cladocerans, copepods and rotifers.

Books Recommended

1. Bentley, P. J., Comparative Vertebrate Endocrinology, Cambridge University Press, 2000.
2. Bond, C.E., Biology of Fishes, Saunders College Publishing Philadelphia, 1979.
3. Brown, M.E., The Physiology of Fishes Vol. I, II. Academic Press, 1953 & 1957
4. C.I.F.R.I., Prawn Fisheries Bulletin No. 10, 1977.
5. Chakroff, M., Freshwater Fish Pond Culture and Management, Scientific Publishers, 1987.
6. Datta-Munshi, J.S. & Hughes G. M., Air-breathing fishes of India, Oxford and IBH Publ. Co. New Delhi, 1992.
7. Davis, H. S., Culture and Diseases of Game Fishes, University of California Press, 1956
8. Duijn, C. V., Diseases of Fishes, London Iliffe Books Ltd, 1967.
9. Evans, D.H., The Physiology of Fishes, CRC Press, 1998
10. Gopakumar, K., Singh, B.N. and Chitranshi, V.R. Fifty Years of Fisheries Research in India, Fisheries Division Indian Council of Agricultural Research, New Delhi, 2000.
11. Gorbman et al: Comparative Endocrinology, John Wiley & Sons, New York, Chichester, Brisbane
12. Hadley, M. E., Endocrinology, Prentice Hall, International Editions, 2000.
13. Hall, C. B., Ponds and Fish Culture, Agro Botanical Publishers, 1994
14. Hoar W.S. & Randall, D. J., Fish Physiology, Series Vol. I - XIV, Academic Press
15. Hora, S. L. and Pillay, T.V. R., Handbook on Fish Culture in the Indo-Pacific Region, Fisheries Division, Biology Branch, FAO, 1962.
16. Howard & Churchill, Canning technology. London
17. Huet, M., Textbook of Fish Culture, Breeding and Cultivation of Fish, Fishing News (Books) Ltd., 1989.
18. Hughes, G. M. Comparative Physiology of Vertebrate Respiration, Heinemann Educational Books Ltd., 1967
19. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. 1985.
20. Khanna S. S. and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003
21. Kreuzer, R., Fishery products, FAO, Fishing News (Books) Ltd., England. 1974.

22. Kurian and Sebastian. Prawns and Prawn Fisheries of India. Hindustan Publ. Co., 1976.
23. Lagler, K. F. Studies in fresh water fishery biology 1950
24. Lagler, K. F., Bardach J.E., Miller R.R. and May Passino, D.R. Ichthyology, John Wiley, 2003.
25. Nilsson, S. & Holmgren, S., Fish Physiology Recent Advances, Croom Helm, London, 1986.
26. Norman, J. R. and Greenwood P. H. A History of Fishes, Third Ed., Ernest Benn Limited, London. 1975.
27. Norris, D. O., Vertebrate Endocrinology (2nd ed.), Academic Press, 1997.
28. Proceedings of International Symposium on Reproductive Physiology of fishes. 1982, 1987, 1991, 1995, 1999 (68) Piska R. S., Fisheries and Aquaculture, Lahari Publications Hyderabad
29. Ribelin, W. E. & Migaki, G., The Pathology of Fishes, The Univ. of Wisconsin Press, 1975.
Rick Parker, Aquaculture Science, 2nd Edition, Delmar Thomson Learning
30. Rounsfell, G.A. and Everhart, W. H., Fishery Science: It's Methods and Applications, John Wiley & Sons, Indian Reprint International Books and Periodicals Supply Service, New Delhi 1985.
31. Santhanam, R. Fisheries Science, Daya Publishing House, 1990.
32. Singh, B. R. Advances in Fish Research, Vol. I and II Narendra Publishing House, Delhi 1993 and 1997.
33. Srivastava, C.B.L. A Textbook of Fishery Science and Indian Fisheries, Kitab Mahal. 1985
34. The Wealth of India, Raw Materials Vol. IV, Fish and Fisheries, CSIR, 1962.

M.SC.IIZOOLOGY

SEMESTER-IV

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	80
2	Viva)	20

Total :	100 marks
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