



**MAHARSHI DAYANAND SARASWATI UNIVERSITY  
AJMER**

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**MAHARSHI DAYANAND SARASWATI UNIVERSITY  
AJMER**

**पाठ्यक्रम**

**SYLLABUS**

**SCHEME OF EXAMINATION AND  
COURSES OF STUDY**

**FACULTY OF SCIENCE**

**M.Sc. ZOOLOGY**

**M.Sc. (Semester I & II)**

(w.e.f. 2016-17)

**M.Sc. (Semester III & IV)**

(w.e.f. 2017-18)

**संस्करण  
2016**



**मूल्य : 16/-**

**महर्षि दयानन्द सरस्वती विश्वविद्यालय, अजमेर**

MAHARSHI DAYANAND SARASWATI UNIVERSITY,  
AJMER

पाठ्यक्रम

# SYLLABUS

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## NOTICE

1. Change in Statutes/Ordinances/Rules/Regulations Syllabus and Books may, from time to time, be made by amendment or remaking, and a candidate shall, except in so far as the University determines otherwise comply with any change that applies to years he has not completed at the time of change. **The decision taken by the Academic Council shall be final.**

## सूचना

1. समय-समय पर संशोधन या पुनः निर्माण कर परिनियमों/अध्यादेशों/नियमों / विनियमों / पाठ्यक्रमों व पुस्तकों में परिवर्तन किया जा सकता है, तथा किसी भी परिवर्तन को छात्र को मानना होगा बशर्ते कि विश्वविद्यालय ने अन्यथा प्रकार से उनको छूट न दी हो और छात्र ने उस परिवर्तन के पूर्व वर्ष पाठ्यक्रम को पूरा न किया हो। विद्या परिषद द्वारा लिये गये निर्णय अन्तिम होंगे।

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for Maharshi Dayanand Saraswati University, Ajmer

M.D.S.U. Syllabus / M.Sc. Zoology / 3

MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER  
SYLLABUS  
SCHEME OF EXAMINATION AND COURSES OF STUDY  
FACULTY OF SCIENCE  
M.Sc. ZOOLOGY SEMESTER SCHEME  
(WITH EFFECT FROM 2016-17)

### NOTICE

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### M.Sc. ZOOLOGY SEMESTER SCHEME OF EXAMINATION

1. The maximum marks of each Semester Examination will be 300. There shall be two semesters in one year and four Semesters in all. It will be necessary for a candidate to pass in the theory as well as in the practical examination separately. Criteria for pass percentage and division will be as per the university policy for Semester Scheme prescribed uniformly by the university.
2. There will be four theory papers in each of the four Semesters and 16 papers in all. Each paper will have maximum marks of 50 and examination will be of 3 hours duration. There will be one Practical Examination of 5 hours duration in one day with maximum of 100 marks in every Semester.
3. Each theory paper is assigned four hours per week of teaching. Practical classes are assigned 18 hours per week. Seminars are assigned two hours per week which includes seminar presentation along-with text submission.
4. Scheme of examination in Individual Semester and distribution of marks in each paper will be as under :

### Curriculum & Scheme of Examination for M.Sc. Zoology

| Semester Number<br>& Paper Nomenclature        | Total Marks |
|--|-------------|
| <b>Semester I</b>                              |             |
| Paper -1 Taxonomy, Biodiversity and wild Life  | 50          |
| Paper -2 Structure & Function of Invertebrates | 50          |
| Paper -3 Biochemistry & Immunology             | 50          |
| Paper-4 Physiology & Endocrinology             | 50          |
| Paper-5 Practicals                             | 100         |
| <b>Total</b>                                   | <b>300</b>  |
| <b>Semester II</b>                             |             |
| Paper - 6 Molecular Biology& Biotechnology     | 50          |
| Paper - 7 Genetics & Biological techniques     | 50          |
| Paper - 8 Evolution                            | 50          |
| Paper - 9 Quantitative Biology                 | 50          |
| Paper- 10 Practicals                           | 100         |
| <b>Total</b>                                   | <b>300</b>  |
| <b>Semester III</b>                            |             |
| Paper - 11 Biology of Chordates                | 50          |
| Paper - 12 Developmental Biology               | 50          |

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|  |                              |            |
|--|------------------------------|------------|
| Paper - 13                                       | Special Paper A/ B/ C/ D/E/F | 50         |
| Paper - 14                                       | Special Paper A/ B/ C/ D/E/F | 50         |
| Paper- 15  | Practicals                   | 100        |
| <b>Total</b>                                     |                              | <b>300</b> |
| <b>Semester IV</b>                               |                              |            |
| Paper - 16                                       | Ecology                      | 50         |
| Paper - 17                                       | Ethology                     | 50         |
| Paper - 18                                       | Special Paper A/ B/ C/ D/E/F | 50         |
| Paper - 19                                       | Special Paper A/ B/ C/ D/E/F | 100        |
| Paper- 20  | Practicals                   | 300        |
| <b>Total</b>                                     |                              |            |
| Special Paper A- Cell Biology                    |                              |            |
| Special Paper B- Environmental Biology           |                              |            |
| Special Paper C- Entomology                      |                              |            |
| Special Paper D- Fish Biology                    |                              |            |
| Special Paper E- Molecular Developmental Biology |                              |            |
| Special Paper F- Endocrinology                   |                              |            |

**SEMESTER-I****Paper 1- Taxonomy, Biodiversity and wild Life** Max. Marks: 50

Time: 3 Hours

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

**Part-A (10marks):** Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

**Part-B (10 marks):** Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

**Part-C (30 marks):** 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

## 1. Principles of Animal Taxonomy:

a) Rules of nomenclature

2. Principles of classification -

b) Theories of biological classification and their history

c) The concept of species, sub species, Polytypic species

d) Intraspecific categories

e) Evaluation of biodiversity indices, Shannon Weiner Index, Dominance Index, Similarity and Dissimilarity Index

f) Trends in Biosystematics-Chemotaxonomy, Cytotaxonomy and Molecular Taxonomy

g) International Code of Zoological Nomenclature (ICZN): Formation of Scientific names of various Taxa

h) A study of the classification of invertebrates with distinguishing features and examples of various subdivisions

**Unit-II**

1. Biodiversity- Concept, principles and Types of biodiversity
2. Major biodiversity areas of the world: Biodiversity hotspots
3. Indian Biodiversity Areas : Zones of faunal distribution
4. Major protected areas and their importance
5. Causes for the loss of biodiversity
6. Biodiversity conservation methods

**Unit III**

## 1. Wildlife and conservation:

a) Wild life reserves and biosphere reserves

b) National Parks and Sanctuaries

c) Single species/single habitat based conservation programmes - (Project Tiger, Project Gir Lion and Crocodile breeding project)

2. Wildlife in India, Endangered and threatened species

3. Wildlife in Rajasthan with references to reptiles, birds and mammals.

4. India's role and contribution on conservation of wildlife

5. Forestry-Forest resources, erosion, deforestation and afforestation

6. Wildlife protection Act

7. Institutions and their role in conservation-Zoos, Natural history museums, Zoological survey of India, Forest research institute, survey of India, Central marine fisheries research institute and NGOs.

**Suggested Reading Materials:**

- B.H.M.S. - The Preservation of Wild Life in India.
- B.H.M.S.- Wild Animals of India.
- B.K.Tikadar :Threatened animals of India
- Chaudhary A.B.- Sundorbans Mangrove (Ecology and Wild Life).
- Darwin. C. - Origin of Species, Watts & Co. 5 and 6 Johnson's Courts, Fleet Street, E.C. 4, London.
- E. Mayer & Peter D. Ash lock- Principles of Systematic Zoology.
- E. Mayer : Elements of Taxonomy
- E.O.Wilson: Biodiversity, Academic press, Washington
- E.O.Wilson: The diversity of life (the college edition), W W Northern & co.
- G.G Simpson :Principles of Animal Taxonomy. Oxford IBH Publishing Company
- M. Kato: The biology of diversity. Springer
- Romer, A.S. - Vertebrate Palaeontology, University Chicago Press, Chicago, Illinois.

**Paper- 2: Structure and function of Invertebrates**

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

**Part-A (10marks):** Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

**Part-B (10 marks):** Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

**Part-C (30 marks):** 6 questions will be set taking 2 from each unit. Candidate is required



to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Organization of Coelom:

- Acoelomates, Pseudo coelomates and Coelomates
- Protostomia and Deuterostomia

2. Locomotion:

- Amoeboid, Flagellar and Ciliary movement in protozoa
- Hydrostatic movements in Coelenterata
- Annelida and Echinodermata
- Molecular and physiological mechanisms involved in different kinds of movements

3. Nutrition and Digestion:

- Patterns of Feeding mechanisms and digestion -
- Amoeboid feeding, Ciliary feeding, Filter feeding, Parasitic mode of feeding
- Feeding mechanisms in insects and echinoderms

**Unit-II**

1. Respiration

- Organs of respiration : Gills, lungs and trachea.
- Respiratory pigments.
- Mechanism of respiration.

2. Excretion:

- Excretion in lower invertebrates
- Excretion in higher invertebrates
- Organs of excretion: Coelom, Coelomoducts, Nephridia and Malpighian tubes.
  - > Mechanism of Excretion.
  - > Mechanism of Osmoregulation.

3. Nervous System

- Primitive Nervous systems: Coelenterata and Echinodermata
- Advanced nervous system : Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda)
- Receptors: structural and functional organization of the mechanoreceptors, chemoreceptors and photoreceptors.

**Unit-III**

1. Reproduction:

- Reproduction in Protozoa, Porifera
  - Reproduction in Metazoa: Asexual Reproduction in Coelenterata and Polychaetes
  - Sexual Reproduction, Parthenogenesis
  - Endocrine glands, hormones and role of hormones in moulting.
  - Invertebrate larval forms and their evolutionary significance
2. Structure affinities and life history of the following minor Phyla
- Rotifera
  - Entoprocta
  - Phoronida
  - Ectoprocta

**Suggested Reading Materials:**

- Barnes, R.D. Invertebrates Zoology, III edition. W.B. Saunders Co. Philadelphia.

- Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
- Hyman, L.H. The Invertebrates smaller coelomate groups, Vol. V. Mc.Graw Hill Co., New York.
- Hyman, L.H. The Invertebrates, No 1. 1. protozoa through Ctenophora, McGraw Hill Co., New York
- Hyman, L.H. The Invertebrates. Vol. 2. McGraw Hill Co., New York.
- Hyman, L.H. The Invertebrates. Vol. 8. McGraw Hill Co., New York and London.
- Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
- Parker, T.J., Haswell W.A. Text book of Zoology, Macmillan Co., London.
- Read, C.P. Animal Parasitism, Parasitism, prentice Hall Inc., New Jersey.
- Russel-Hunter, W.D. A biology of higher invertebrates, the Macmillan Co. Ltd., London.
- Sedgwick, A.A. Student text book of Zoology. Vol. I,II and III. Central Book Depot, Allahabad.

**Paper- 3: Biochemistry and Immunology**

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

- Organic constituents in the living systems:
  - Definition, general properties, classification, configuration and importance of Carbohydrates, Proteins and Lipids.
- Nucleoproteins:
  - DNA : Double helical structure of DNA, DNA replication, recombination and repair
  - RNA: Structure of RNA, role of RNA in gene expression, RNA synthesis and splicing
- Enzymes: Terminologies, classification and basics of enzyme kinetics
- Vitamins: Classification, structure, occurrence and functions of fat soluble and water soluble vitamins

**Unit-II**

2. Basic concepts of metabolism: Catabolism, Anabolism, Metabolic pathway, regulation, concept of free energy

- Carbohydrate metabolism: Enzymatic reaction, regulation and importance

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of Glycolysis, Citric acid cycle, Pentose phosphate pathway, glycogenolysis, glycogenesis, gluconeogenesis.

- b) Lipid metabolism: fatty acid oxidation, fatty acid biosynthesis, biosynthesis of triglycerides, Cholesterol
- c) Amino acid metabolism: Catabolism of amino acid, transamination, deamination, biosynthesis of nonessential amino acid, fate of carbon skeleton
- d) Nucleotide metabolism: Degradation of purine and pyrimidines nucleotides, biosynthesis (De novo, salvage pathways) of purine and pyrimidine nucleotides

## 3. Oxidative phosphorylation and mechanism of ATP biosynthesis.

## Unit-III

1. Overview of the immune system:
  - a) Components of the immune system
  - b) Principles of innate and adaptive immunity
  - c) The recognition and effector mechanisms of the adaptive immunity- antigen and immunogenicity
  - d) Clonal selection theory.
2. Antigen recognition by immune cells
3. Effector mechanisms and regulation of immune responses
4. Immunity in health and disease

## Suggested Reading Materials:

- Clark & Swizer. Experimental Biochemistry. Freeman, 2000. A biologist Guide to principles and Techniques of Practical Biochemistry-
- Cooper, T.G. Tools of Biochemistry
- Creighton, T.E. Protein Structure and Molecular Properties W.H. Freeman & Co.
- Freifelder, D. Essentials of Molecular Biology
- Freifelder, D. Physical Biochemistry W.H. Freeman & Co.
- Garland Science Publishing, New York, USA.
- Garret, R.H. and C.M. Grisham. Biochemistry. Saunders college Publishers.
- Hawk, Practical Physiological Chemistry
- Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, (6th Ed., 2005),
- Immunology, David, Brostoff and Roitt, (7th Ed., 2006), Mosby & Elsevier Publishing, Canada, USA.
- K. Wilson and K.H. Goulding EIBS Edn.
- Kuby Immunology, Richard, Thomas, Barbara, Janis, (5th Ed., 2003), W. H. Freeman and company, New York, USA.
- L. Lummer (ed), Practical Biochemistry, Tata McGraw Hill
- Segal, I.H. Biochemical calculations John Wiley and Sons
- Voet, D. and J.G. Voet. Biochemistry John Wiley & Sons.
- Wilson, K. and K.H. Goulding A Biologists Guide to Principles and Techniques of Practical Biochemistry

## Paper- 4: Physiology and Endocrinology

Max. Marks: 50

Time: 3 Hours

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

## UNIT-I

## 1. Digestive system:

- a) Nature of food-stuff
- b) Various types of digestive enzymes and their action in alimentary canal,
- c) Absorption and assimilation of food
- d) Nervous and hormonal control of digestion
- e) Energy balance

## 2. Circulatory system:

- a) Composition and function of blood,
- b) Haemopoiesis, blood clotting, Blood volume, blood volume regulation,
- c) Immunity, homeostasis,
- d) Myogenic heart, ECG - its principle and significance, cardiac cycle,
- e) Heartbeat, blood pressure and blood groups.

## 3. Respiratory system:

- a) Respiratory organs (gills, trachea and lungs), respiratory pigments
- b) Mechanism of breathing,
- c) Physiology of respiration, control of breathing,
- d) Aerodynamics and BMR.

## UNIT-II

## 4. Excretory system:

- a) Comparative physiology of excretion,
- b) Functional architecture of kidney and nephron,
- c) Nitrogenous end products, formation of urine and its hormonal control,
- d) Role of kidney in osmoregulation, urine concentration,
- e) Waste elimination, micturition
- f) Electrolyte balance, acid-base balance.

## 5. Muscular system:

- a) Types and properties of muscles,
- b) Functional architecture of skeletal muscles,
- c) Biophysical and biochemical events during muscular activity.

## 6. Nervous system:

- a) Functional architecture of neurons,
- b) Origin and propagation of nerve impulse through axon, Action potential, synaptic transmission,
- c) Reflex arc and reflex action,
- d) Gross neuroanatomy of the brain and spinal cord,
- e) Central and peripheral nervous system,

## UNIT-III

## 7. Sense organs:

- a) Structural architecture and functioning of eyes and ears,

- b) Tactile response.
- c) Thermoregulation and cold tolerance:
- d) Heat balance and exchange, endotherms Vs ectotherms,
- e) Counter-current heat exchanger,
- f) Torpor, hibernation and aestivation,

8. Endocrine glands in vertebrates, their hormones and related diseases.

9. Reproduction:

- a) Reproductive cycle,
- b) Reproductive processes (implantation, parturition and lactation)

10. Neuro-endocrine regulators in insects and mammals, pheromones.

**Suggested Reading Materials:**

- C.R. Martin- Endocrine Physiology-Oxford University Press.
- EJW Barrington-General & comparative Endocrinology-Oxford, Clarendon Press
- R.H. Williams-Text Book of Endocrinology-W.B. Saunders
- Eckert -Animal Physiology Mechanisms and Adaptation. R. Eckert (ed), 5th edition, W.H. Freeman and Company, New York.
- W.S. Hoar (ed)- General and Comparative Animal Physiology-Prentice Hall of Indian.
- K.S. Schiemdt Neilsen (ed) - Animal Physiology: Adaptation and Environment, University Press, Cambridge, UK.
- Strand, F.L.- A regulatory Systems Approach. Physiology: Macmillan Publishing Co., New York.
- C.L. Prosser (ed)- Environmental and Metabolic Animal Physiology, Wiley-Liss Inc., New York.
- P.Willmer, G. Stone, and I. Johnson (eds)- Environmental Physiology, Blackwell Publishing, Oxford, UK.
- R.C.Newell (ed) - Adaptation to Environment: Essays on the Physiology of Marine Animals. 1976. Butterworths, London, UK.
- G.N. Louw- Physiological Animal Ecology, Longman Publishing Group, Harlow, UK.
- A. Gorbman et al- Comparative Endocrinology, John Wiley & Sons.

#### Paper 5: Practicals

**Taxonomy, Biodiversity & Wild Life**

- Use of taxonomic keys to identify at least 6-10 orders of insects (up to order level only).
- Composition/ assessment of taxonomic diversity in a habitat. (grassland, arid land, wet land etc.)
- Write characteristics of different biomes and mark their location on world map
- Mark major rivers of world on world map and five riverine system of India on India map- visit a river or pond-submit a write up
- Make a diagram of zones of sea, write characteristics of each-visit any sea-submit a report
- Understand about coral reef, their types, structure and their mark their location in world and India's map

- Mark major Ecozones of India on India's map-visit a desert, grass land or rain forest submit a write up
- Mark important sanctuaries and national parks of Rajasthan on map, and write details of any three

**Structure & Function of Invertebrates**

- Identification, Classification and study of the animals from major invertebrate groups (Protozoa to Hemichordate including minor phyla)
- Larvae- Planula, Redia, Cercaria, metacercaria, Trochophore, Nauplius, Zoea,
- Mysis, Phyllosoma, Trilobite larvae of limulus, Antedon, Veliger, Bipinnaria, Ophiopluteus, Echinopluteus, Auricularia, tornaria
- Virtual dissection of invertebrates using computer software

Or

- Dissection: Nervous System, Leech, crab of Scorpion, Mytilus, Sepia, Aplysia, Sea Urchin, Holothuria, Star Fish.
- Permanent Mounting

**Biochemistry**

- Identification of protein, carbohydrate and lipid in various tissues/food material
- Identification of different kinds of mono-di and polysaccharides in biological /food materials.
- Verification of Beer-Lambert's Law using any colour solution
- Determination of absorption maxima of a coloured solution
- Plotting of standard curve
- Quantative estimation of the following in various tissues
- Carbohydrates: Glycogen, glucose and ascorbic acid.
- Proteins :Total proteins
- Lipids: Total lipid, Phospholipids and cholesterol.
- Nucleic acid: DNA and RNA
- Enzymes: Acid and alkaline phosphates
- Paper chromatography: unidimensional chromatography, using amino acids from purified samples and biological materials.
- Paper /PAGE electrophoresis, determination of serum protein through paper /PAGE
- electrophoresis
- Determination of pH of different solutions

**Physiology & Endocrinology**

- Demonstration of the use and operation of oscilloscope for recording neuroelectric activity and electrocardiogram.
- Photometric determination of haemoglobin in blood sample.
- Determination of MCV, MCH, MCHC and colour Index of the given sample of blood.
- Demonstration of the blood clotting time, erythrocyte sedimentation rate, haemolysis and crenation.
- Determination of the urea in urine
- Determination of the glucose in urine.
- Radiation uptake in various tissues: elementary idea of using radioactivity detection instruments.

- Study of digestive enzymes in different parts of the alimentary canal.

**Seminar –**

Students have to prepare and present paper on the related topics or recent advances/research in the field of life sciences/ topics related to the papers included in the semester. Student shall prepare and use power point presentations, models, slides etc. for seminar.

**Note:**

- (i) Use of animals for dissection and practical work is subject to the conditions that these are not banned under the Wildlife Protections Act.
- (ii) Those Institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/slides/models/photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimens with the help of charts/slides/models/photographs and digital alternatives and visit of students to already established museums.

**Instructions for Practicals****Max Marks: 100****Time: 05 Hours**

The Board of Examiners will constitute of one External Examiner and one Internal Examiner.

| Distribution of Marks                        | Marks      |
|--|------------|
| 1. Spotting                                  | 24         |
| 2. Dissection /Permanent Mounting            | 8          |
| 3. Exercise on Biodiversity/ Wild Life       | 8          |
| 4. Exercise on Biochemistry                  | 10         |
| 5. Exercise on Physiology                    | 10         |
| 6. Insect Identification using Taxonomic key | 10         |
| 7. Seminar                                   | 10         |
| 8. Viva                                      | 10         |
| 9. Record                                    | 10         |
| <b>Grand Total</b>                           | <b>100</b> |

**SEMESTER-II****Paper 6- Molecular Biology & Biotechnology****Max. Marks: 50****Time: 3 Hours****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**UNIT I**

- General account of Nucleic acids
  - DNA replication

- Prokaryotic and eukaryotic DNA replication.
  - Mechanics of DNA replication.
  - Enzymes and accessory proteins involved in DNA replication.
- Transcription
    - Prokaryotic transcription.
    - Eukaryotic transcription.
    - Regulatory elements and mechanisms of transcription regulation.
    - Transcription termination – attenuation and antitermination.
    - Gene silencing.
  - Post-transcriptional modifications in RNA
    - 5'- Cap formation.
    - End processing and polyadenylation.
    - Splicing and editing.
    - Nuclear export of mRNA.
    - RNA stability.
  - Translation
    - Genetic code
    - Prokaryotic and eukaryotic translation
    - Regulation of translation
    - Co-and post-translation modifications of proteins.

**UNIT II**

- Recombination and repair
  - Holiday junction.
  - FLP/FRT and Cre-Lox recombination.
  - Rec A and other recombinases.
  - DNA repair mechanisms.
- Molecular mapping of genome
  - Genetic and physical maps
  - Southern hybridization, fluorescence in situ hybridization (FISH) for
  - Genome analysis.
  - Molecular markers in genome analysis (RFLP, RAPD and AFLP)
  - Application of RFLP in forensic, disease prognosis, genetic counseling and pedigree analysis.
  - DNA Sequencing, Sequencing methods, sequence submission, sequence alignment, DNA fingerprinting
- Signal transduction in bacteria and animals, Complementation and molecular recognition, liposomes.
- Molecular biology of Cancer, Oncogenes, Chemical Carcinogenesis, transpo genes

**UNIT III**

- Transgenic animals and knock-outs
  - Production
  - Applications
  - Embryonic stem cells
  - Care & breeding of experimental animals
  - Bioethics
- Assisted reproduction technologies
  - Embryo sexing and cloning.



- b) Screening for genetic disorders.
- c) ICSI, GIFT etc.
- d) Cloning of animals by nuclear transfer.

## 3. Assays

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

4. Microscopy – Principles of light, transmission, scanning, electron, phase-contrast.

5. Microphotography, Image analysers and their applications.

**Suggested Reading Materials:**

- B. Alberts, D-Bray, J.Lewis, M. Raff, K. Roberts and J.D. Watson, Molecular Biology of the cell- Garland Pub. New York.
- Benjamin Lewin : Gene VI Oxford University press. UK
- J D Watson, N H Hopkins, J W Roberts, J A Stcitiz, and A M Weiner: Molecular biology of the gene: The Benjamin/Cummings pub. Co.Inc., California
- J Darnell, H Lodish and D Baltimore : Molecular cell biology. Scientific American books.Inc USA.
- J Sambrook, E F Fritsch and T Maniatis Molecular cloning: A laboratory Manual. Cold spring Harbor laboratory press, New York
- John R W Masters ed Animal cell culture- A practical approach, IRL press
- K. Wilson and K.H. Goulding A Biologists guide to Principles and techniques of Biochemistry, ELBS Edu.
- New York.
- P.D.Dabre, Introduction to Practical Molecular Biology, John Wiley & Sons Ltd.
- publishers Inc. New York
- R A Meyers.(Ed) Molecular biology and Biotechnology. A comprehensive desk reference. VCH
- Robert Braun Introduction to instrumental analysis; McGraw Hill International Editions
- T.A.Brown Molecular Biology Lab Fax, (Ed.), Bios Scientific Publishers Ltd.

**Paper- 7: Genetics & Biological techniques****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

2. Mendel's laws and their significance, Current status of Mendelism
3. Detailed study of Mutation and mutagenic agents
4. Variations in Chromosome numbers
5. Genetic interactions

6. Multiple gene inheritance
7. Multiple Alleles
8. Cytoplasmic inheritance and maternal effects
9. Sex determination mechanisms, genic balance theory; gynandromorphs
10. Cytogenetics of human chromosomes

**Unit-II**

1. Human heredity: Important human characters and their inheritance
2. Principles of Eugenics
3. Prenatal diagnosis & Genetic Counselling
4. Genetic screening, Genetic disorders
5. Structural Genomics, Functional Genomics, Gene libraries
6. Regulation of gene expression in Prokaryotes and Eukaryotes (Operon concept)
7. DNA fingerprinting
8. Principles methods and application of Genetic Engineering; Recombinant DNA technology; In situ hybridization.
9. Genetic code, structure and regulation of genes, Recombinant DNA technology, In situ hybridization, Genetic engineering

**Unit-III**

1. Microbiological techniques
2. Media preparation and sterilization
3. Inoculation and growth monitoring
4. Use of fermentors
5. Biochemical mutants and their use
6. Separation techniques in Biology
7. Cell culture techniques
8. Cryotechniques
9. Principles and applications of tracer techniques in biology
10. Effect of radiation on biological systems

**Suggested Reading Materials:**

- A.M. Winchester: Genetics
- Bengt A. Kihlman: Actions of chemicals of dividing cells
- Boyer. Modern Experimental Biochemistry. Benjamin, 1993
- Cooper. The Cell-A Molecular Approach. ASM, 1997
- Edgar Altenbrg: Genetics
- Freifelder. Physical Biochemistry. Freeman, 1982.
- Introduction to instrumental analysis-Robert Braun-McGraw Hill.
- John R.W. Masters. Animal Cell culture- A practical approach. IRL Press.
- L.C. Dunn, principals of Genetics
- L.C. Dunn: Genetics and the origin of species
- Locquin and Langeron. Handbook of Microscopy. Butterwaths, 1983
- Philip E. Hartman Gene Action
- Robert Braun. Introduction to instrumental analysis. McGraw Hill
- Wilson and Wlaker. Practical Biochemistry. Cambridge, 2000.
- Robert Braun Introduction to instrumental analysis- McGraw Hill.
- K, Wilson and K.H. Goulding A biologist Guide to principles and Techniques of Practical Biochemistry-EIBS Edn.

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Concept of Evolution and theories of Organic Evolution (Lamarckism, Darwinism, Mendelism)
2. Major transitions in Evolution.
3. Neo- Darwinism
4. Hardy-Weinberg law of genetic equilibrium
5. Characteristics of evolution- extinction, replacement, irreversibility of specialization etc.
6. A detailed account of destabilizing forces and mechanisms of Evolution:
  - a) Natural selection
  - b) Mutations
  - c) Genetic Drift
  - d) Migration
  - e) Meiotic drive
7. Quantifying genetic variability
  - a) Genetic structure of natural populations
  - b) Phenotypic Variations
  - c) Models explaining changes in genetic structure of populations
  - d) Factors affecting human disease frequency

**UNIT II**

1. Molecular population genetics
  - a) Patterns of change in nucleotide and amino acid sequences
  - b) Ecological significance of molecular variations
  - c) Emergence of Neo-Darwinism- neutral hypothesis
2. Genetics of quantitative traits in populations
  - a) Quantitative traits and natural selection
  - b) Estimation of heritability
  - c) Genotype-environment interactions
  - d) Inbreeding depression and heterosis
  - e) Molecular analysis of quantitative traits
  - f) Phenotypic plasticity
3. Genetics of speciation - Definition of species, sub species and races, Speciation a gradual or a sudden process
4. Isolation and its role in species formation:
  - a) Isolating mechanisms- Geographical, Ecological, Physiological, Bio-

Chemical, Anatomical, Developmental, Behavioural, Psychological and Social

b) Effects of Isolation- Restriction of random dispersal and random mating, character displacement, reduction of fertility

c) Failure of isolation mechanisms, gene flow, migration, heterosis

**Unit-III**

1. Population as a unit of Evolution, gene frequency, gene pool, result of change in gene frequency
3. Adaptational diversity and nature of adaptations, adaptive radiations and occupation of new environments and niches
4. Mimicry and colouration
5. Molecular Evolution
  - a) Gene Evolution
  - b) Assessment of molecular variation
6. Origin of higher categories
  - a) Major trends in origin of higher categories
  - b) Micro and Macro Evolution
7. Molecular Phylogeny
  - a) Phylogenetic trees
  - b) Phylogenetic inferences
  - c) Nucleic acid phylogeny-DNA, DNA hybridizations, Restriction enzyme sites, Nucleic acid comparisons and homologies.

**Suggested Reading Materials:**

- Dobzhansky, Th. F.J. Ayala, G.L. Stebbins and J.M. Valentine Evolution. Surject Publication, Delhi.
- Hartl, D.L. A Primer of Population Genetics. Sinauer Associates, Inc. Massachusetts.
- Jha, A.P. Genes and Evolution. John Publication, New Delhi.
- King, M. Species Evolution- The Role of chromosomal change. The Cambridge University Press, Cambridge.

**Paper- 9: Quantitative Biology**

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**UNIT I**

1. Computer applications in Zoological study
  - a) Fundamentals of computer
  - b) Elementary idea of operating system
  - c) Software used in bio medical sciences (image analysis and system automation)

2. Introduction to Biostatistics
3. Definition, Objectives and significance of Biostatistics
4. Important terminology and Statistical symbols
5. Scope & Applications of Biostatistics
6. Graphical and tabular presentation of data - bar diagrams, histograms, frequency polygons, pie diagrams and line diagrams

**UNIT II**

1. Basic Statistics -- Average (mean, median, mode)
2. Measures of Variability
3. Mean deviation
4. Standard deviation
5. Correlation and Regression
6. Types of correlation
7. Methods of studying correlation
8. Regression analysis
9. Uses of Regression analysis
10. Statistics of dispersion, coefficient of variation

**UNIT III**

1. Probability distribution (Binomial, Poisson and normal)
2. Standard error, Confidence limits
3. Tests of Significance
4. Significance of difference in means
5. Student's t-test
6. F-test
7. Chi-square test
8. Testing goodness of Fit
9. Chi-square distribution and characteristics
10. Applications of Chi-square test
11. Yate's correction
12. Analysis of Variance
  - a) One-way classification
  - b) Two-way classification

**Suggested Reading Materials:**

- Allan Bluman Elementary Statistics: A Brief Version (5th Edition)
- Dohzhansky, Th., F.J. Alaya, G.L. Stebbins & J.M. Valentine, Genetics and Origin of Species. Surjeet Publication, Delhi
- Encyclopedia of Evolution Vol I and Vol II- By Mark Pagel, Oxford
- Futuyama, Evolutionary Biology D.J. Suinuaner Associates, INC Publishers.
- Green, R.H. Sampling design and statistical methods for environmental biologists. John Wiley & Sons, New York.
- Hart, D.L.A Primer of Population Genetics. Suinuaner Associate, Inc.
- Jha A.P. Genes and Evolution John Publication, New Delhi
- Klug, M. Species Evolution- The role of chromosomal change. Cambridge Massachusetts.
- Merral, D.J. Holt, Rinehart and Winston, Inc. Evolution and Genetics
- Murray, J.D. Mathematical biology. Spinger-Verlag, Berlin. Publishers.
- Rashmi Sisodia, Evolution and population genetics, Paragon, International

- Smith, J.M. Evolutionary Genetics. Oxford University Press, New York.
- Snedecor, H.W. and W.G. Cochran, Statistical methods. Affiliated East-West Press, New Delhi (Indian ed.).
- Sokal, R. R. and Rolf F. J. Biometry : Freeman, San Francisco, US Affiliated East-West Press, New Delhi.
- Strickberger, Evolution M.W. Jones and Barlett Publishers, Boston London Sunderland. University Press, Cambridge.

**Paper- 10 : Practicals****Practicals****Molecular Biology & Biotechnology**

- Permanent slides: Types of cells (squamous, cuboidal, columnar epithelial cells, blood cells, nerve cells, muscle cells), connective tissues of various types. Adipose tissue, mitotic & meiotic chromosomes and their different phases.
- Study of mitosis in onion root tip and mammalian bone marrow cells.
- Study of Meiosis in testes of insect or mammal.
- Study of giant chromosomes in the salivary gland of Chironomus larva or
- Drosophila
- Vital and supravitral staining (with Neutral red and Janus green (B) of cells of the testis of an insects or mammal to study mitochondria.
- Preparation of multipolar nerve cell from the spinal cord of a mammal.
- Exercise based on DNA fingerprinting, DNA sequencing.
- Observation of cellular organization of testes of Cockroach and Grasshopper by Acetocarmine, Feulgen staining preparations/ slides/ digital techniques.
- Chromosome counts in cells of the testis of an insect pest/ bone marrow cells of rodent pest.
- Preparations and staining of Barr bodies.
- Immunoassays RIA, ELISA
- SDS PAGE of soluble proteins and determination of molecular weight.

**Genetics & Biological Techniques**

- Culture and identification of male and female Drosophila.
- Identification of wild and mutant forms of Drosophila.
- Mono- and Dihybrid inheritance in Drosophila.
- Simple problems based on Mendalism to be done by the students.
- Identification of blood groups in man.
- Demonstration of sex chromatin.
- Demonstration of different types of Microscopes
- Demonstration of different types of Spectrophotometers
- Demonstration of Chromatographic equipment
- Demonstration of Electrophoresis equipment.
- Exercise based on DNA fingerprinting, DNA sequencing.
- Chromosome preparations from rat bone marrow and polytene chromosomes.
- Handling of Drosophila, Drosophila genetic crosses, Induction of mutation in Drosophila by
- P-M mutagenesis.
- Karyotyping



- Visit to tissue culture lab

**Evaluation**

- Numericals based on theory
- Project report based on Study tour/ Field Trip
- Exercise based on the syllabi may be devised according to the availability of equipments/need.

**Quantitative Biology –**

- Preparation of frequency tables, histograms, frequency curves, ogives and pie diagrams.
- Problems based on statistical average-Mean, Median, Mode etc.
- Calculation of standard deviation and coefficient of variation.
- Estimation of significance between samples using Student's t-test, F-test and Chi square test.
- Plotting of regression lines, calculation of correlation and regression analysis.
- Analysis of variance (One-way & Two-way classification).
  - ◊ Some exercises based on the syllabi may be devised according to the availability of equipments.

**Seminar –**

Students have to prepare and present paper on the related topics or recent advances/ research in the field of life sciences/ topics related to the papers included in the semester. Student shall prepare and use power point presentations, models, slides etc. for seminar.

**Note:**

- Use of animals for dissection and practical work is subject to the conditions that these are not banned under the Wildlife Protections Act.
- Those Institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/slides/models/photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimens with the help of charts/slides/models/photographs and digital alternatives and visit of students to already established museums.

**INSTRUCTIONS FOR PRACTICALS****Max Marks: 100****Time: 05 Hours**

The Board of Examiners will constitute of one External Examiner and one Internal Examiner.

**Distribution of Marks**

|  | Marks      |    |
|--|------------|----|
| 1. Exercise based on Molecular Biology     | 10         |    |
| 2. Exercise based on Biotechnology         | 10         |    |
| 3. Exercise based on Genetics              | 10         |    |
| 4. Exercise based on Biological techniques | 10         | 10 |
| 5. Exercise based on Quantitative Biology  | 10         |    |
| 6. Computer based Exercise                 | 10         |    |
| 7. Project Report/ Field Trip              | 10         |    |
| 8. Seminar                                 | 10         |    |
| 9. Viva                                    | 10         |    |
| 10. Record                                 | 10         |    |
| <b>Grand Total</b>                         | <b>100</b> |    |

**SEMESTER- III****Paper-11 Biology of Chordates (Compulsory)****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

**Part-A (10marks):** Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

**Part-B (10 marks):** Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

**Part-C (30 marks):** 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Origin and outline classification of chordates.
2. Interrelationships of Hemichordata, Urochordata and Cephalochordata and their relations with other Deuterostomes.
3. Life history of sessile and pelagic tunicates and ascidian, Pyrosoma, Salpa, Doliolum and Oikopleura.
4. Origin, evolution and adaptive radiation of vertebrates.
5. Origin, evolution and general characters of Agnatha (Ostracoderms and Cyclostomes)

**Unit- II**

1. The early Gnathostomes (Placoderms)
2. A general account of the Elasmobranchi, Holocephali, Dipnoi and Crossopterygi.
3. Adaptive radiation in bony fishes.
4. Origin, evolution and adaptive radiation of Amphibia.
5. Origin and evolution of Reptiles; the conquest of land. Seymouria and related forms; Cotylosauria, basic skull types and outline classification of Reptiles.
6. Dinosaurs: types and evolutionary significance.

**Unit-III**

1. Origin and evolution of birds.
2. Origin of flight and flight adaptations.
3. Origin of mammals.
4. Primitive mammals - Protochordates and Metatheria.
5. A general survey of the main radiations in the eutherian mammals (excluding the detailed reference to the individual orders).
6. Evolution of man, relationships of man with other primates, fossil record of man's ancestry.

**Suggested Reading Materials:**

- Carter, G.S. Structure and habit in vertebrate evolution – Sedgwick and Jackson, London.
- Kent, C.G. Comparative anatomy of vertebrates
- Kingsley, J.S. Outlines of Comparative Anatomy of Vertebrates, Central



- Book Depot, Allahabad,
- Malcom Jollie, Chordata morphology. East - West Pres Pvt. Ltd., New Delhi.
  - Milton I Hildergrand. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc., New York.
  - Parker & Haswell to III Rev. by Marshall willians latested Macmillan Co. ltd.
  - Romer, A.S. Vertebrate Body, IIIrd Ed. W.B. Saunders Co., Philadelphia
  - Sedgwick, A.A. Students Text Book of Zoology, Vol.II.
  - Smith, H.S. Evolution of Chordata structure. Hold Rinchart and Winstoin Inc. New York.
  - Walter, H.E. and Sayles, L.D. Biology of vertebrates, MacMillan & Co. New York.
  - Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Edn. McGraw Hall Book Co., New York.
  - Young J.Z. Life of mammals. The Oxford University Press, London
  - Young J.Z. life of vertebrates. The oxford University Press, London

**Paper-12 Developmental Biology (Compulsory)****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Theories of development - Preformation and Epigenesis.
2. Gametogenesis:
  - (i) Spermatogenesis
  - (ii) Oogenesis
    - a) Detailed account of growth phase
    - b) Organization of egg cytoplasm and role of egg cortex
    - c) Morphogenetic determination in egg cytoplasm
3. Fertilization
  - a) Types of fertilization
  - b) Events during fertilization ( Approximation of gametes, chemotaxis, fertilizin-antifertilizin reaction, capacitation of sperm, formation of fertilization cone, fusion of gametes, formation of fertilization membrane and prevention of polyspermy and role of membrane potential in prevention of polyspermy)
  - c) Significance of fertilization and essence of activation of the egg.
4. Early embryonic development :
  - a) Patterns of cleavage, blastulation
  - b) Fate maps

- c) Morphogenetic movements
  - d) Mechanism and significance of gastrulation
3. Cytoplasmic determinants and autonomous cell specification:
    - a) Cell commitment and differentiation.
    - b) Germ cell determinants
    - c) Germ cell migration.
    - d) Progressive cell - cell interaction and cell specification.

**Unit-II**

1. Body Axes:
  - a) Establishment of Body axes in mammals and birds.
  - b) Proximate tissue interactions
2. Casual basis of development: Primary embryonic induction -
  - a) Concept of potencies, prospective fates, progressive determination, totipotency and pluripotency, nuclear transfer experiment.
  - b) Induction of the primitive nervous system (Spemann's primary organizes)
  - c) Nature and regionally specific properties of inductor.
  - d) Competence.
  - e) Abnormal inductors.
  - f) Chemistry and mechanism of action inducing substances.
  - g) Cell differentiation and differential activity.
3. Early vertebrate development :
  - a) Neurulation and ectoderm
  - b) Mesoderm and endoderm
4. Cell diversification in early animal embryo :
  - a) Morphogen gradients
  - b) Embryonic stem cells
5. Organogenesis :
  - a) Morphogenetic process in epithelia and mesenchyme in organ formation
  - b) Morphogenesis of brain and neural crest cells
  - c) Development of eye, heart and alimentary canal
  - d) Genetic regulations on early embryonic development

**Unit - III**

Specific aspects of development:

1. Embryonic adaptations:
  - a) Evolution of cleidoic egg and its structural and physiological adaptations.
  - b) Development and physiology of extraembryonic membranes
  - c) Evolution of viviparity
  - d) Development, types and physiology of mammalian placenta
2. Regeneration :
  - a) Types of regeneration, physiological, reparative and compensatory hypertrophy, regenerative capacity in chordates
  - b) Morphological and histological process in Amphibian limb regeneration
  - c) Origin, re-differentiation of cells of regeneration.

- d) Reasons for the absence of limb regeneration in mammals.
  - e) Methods for induction of regeneration
3. Tetrapod limb development
  4. Hemopoietic stem cells
  5. Metamorphosis:

- a) Amphibian metamorphosis
- b) Insect metamorphosis

**Suggested Reading Materials:**

- Long J.A. Evan H.M. 1922 : the oestrous cycle in the Rat and its associated phenomenon.
- Nalbandou. A.C. – Reproductive physiology
- Prakash A.S. 1965-66 Marshall's, Physiology Reproduction (3 Vol.)
- Gilbert, S.F. Developmental Biology, Sinauer Associated Inc. Massachusetts.
- Ethan Bier, the cold Spring. The cold spring Harbor laboratory Press, New York.
- Balinsky B.I. Introduction to Embryology sanders, Philadelphia.
- Berril N.J. and Karp. G Development Biology. McGraw Hill New York.
- Davidson, E.H. Gene Activity During Early Development. Academic Press, New York.

**Paper - 15****Practical work based on General Papers 11 & 12****1. Chordates:**

1. Virtual dissections using computer software

## a) Dissections:-

- Cranial Nerves of Wallago attu or any other locally abundant fish
- Neural Complex of Herdmania
- Accessory respiratory organs of Heteropneustes fossilis
- Labyrinthine organs of Anabas testudinus

## 2. Museum specimens:

- Lower Chordates: Salpa Asexual and Sexual stage, Doliolum oozoid, Botrylus, Herdmania, and Amphioxus.
- Pisces: Petromyzon, Myxine, Rhinobatus, Pristis, Trygon, Chimaera, Polydon, Acipenser, Amia, Lepidosteus, Protopterus, Lepidosiren, Neoceratodus, Notopterus, Exocoetis, Echeinis, Pleuronectes, Mestacembelus, Diodon, Tetradon, Ostracion, Lophis, Syngnathus, Hippocampus, Anguilla, Labeo, Ophicephalus.
- Amphibia: Ichthyophis, Necturus, Proteus, Ambystoma, Axolotal, Salamander, Siren, Alytes, Pipa, Bufo, Hyla, Rhacophorus, Rana.
- Reptilia: Testudo, Chelonea, Sphenodon, Calotes, Hemidactylus, Phrynosoma, Draco, Varanus, Chamaleon, Cobra, Hydrophis, Rattle Snake, Viper, Pit Viper, Krait, Eryx, Gravidialis.
- Aves: Taylor Byrd, Indiana Hoel, Jungle fol, Pavois, Columbia, Psittacula, Wood pecker, Bubo, Archéopteryx, Flamingo, cormorant.
- Mammals: Ornithorhynchus, Echidna, Macropus, Hedgehog, Manis, Loris, Bat, Mongoose, Hystrix, Otter.

## 3. Microscopic Slides:

- Lower Chordates: Herdmania spicules, Herdmania tadpole larva, Amphioxus T. S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Ammocoete larva- whole mount.
- Pisces: Placoid scale, Cycloid scale, Ctenoid scale.
- Amphibia: V S skin of Frog, T S passing through stomach, duodenum, intestine, liver, pancreas, lung, kidney, testes, ovary, spinal cord, bone.
- Reptilia: V S skin of lizard.
- Aves: V S skin of bird, contour feather, down feather.
- Mammals: V S skin of mammals, T S passing through stomach, intestine, liver, pancreas, kidney, testes, ovary, thyroid gland, adrenal gland, pituitary gland, lung, bone, spinal cord, Blood smear, Simple cuboidal epithelium, Simple columnar epithelium, Simple squamous epithelium, Adipose tissue, Reticular tissue.

## 4. Comparative Osteology:

- Comparative study of Axial and Appendicular skeleton from fish to mammals, with particular reference to the important skull types in Reptiles, Birds and Mammals using charts/ slides/ models/ computer software.

## 5. Permanent preparations :

Placoid, Cycloid and Ctenoid scales. Different types of muscle fibres of house rat. Other possible mountings.

## 2. Developmental Biology –

- Study of development of frog or toad.
- Observation of stages of development of frog in nature.
- Permanent microscopic slides of sections through successive embryonic and larval stages.
- Study of development of chick through – Permanent whole mounts of various stages.
- Permanent microscopic slides of sections through representative regions of successive embryonic stages.
- Removal of chick embryos 18, 24, 33, 72 and 92 hrs. from the egg and their study and identification in the living state.
- Study of the foetus with placenta in the house rat. Digital alternatives may be used.

## Note -

- (i) Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.
- (ii) External features and anatomy should be studied preferably by digital techniques and the alternatives whenever live animal is studied it should be either pest or culturable species without painning them.
- (iii) Those institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/ slides/ models/ photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimen with the help of charts/ slides / models / photographs and digital alternatives/ and visit of students to already established museums.

**Scheme of Practical Examination & Distribution of Marks.**

|  |                |
|--|----------------|
| (Duration: Four hours)                         | Max Marks : 50 |
| a. Internal Organization of vertebrate         | 6 Marks        |
| b. Permanent Preparation                       | 5 Marks        |
| c. Exercise in Developmental Biology           | 5 Marks        |
| d. Identification and comment on spots (eight) | 24 Marks       |
| e. Viva-voce                                   | 5 Marks        |
| f. Class record                                | 5 Marks        |
| Total 50 Marks                                 |                |

**Paper- 13 A: Cell Biology (Special Paper)****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit - I**

- The cell and its diversity.
  - Diversity of cell and cell theory.
  - Diversity of cell - Viruses, Bacteria, Prokaryotes, Eukaryotes (Blood cell.
  - Nerve cell, gland cell and Muscle cell
- Cell wall :
  - Prokaryotic cell wall, peptidoglycan structure Gram positive
- Biomembrane :
  - Variation among membrane.
  - Molecular organization of cell membrane :-  
Lipid : Phospholipids, glycolipids  
Proteins : Intrinsic and extrinsic proteins  
Carbohydrates
  - Mobility of lipids and integral proteins in biomembranes
  - Historical models of plasma membrane
  - Fluid mosaic model
  - Modification of fluid mosaic model
- Cell - Junctions :
  - Gap, tight, desmosomes, microvilli etc.

**Unit - II**

- Transport across membrane
  - Diffusion, facilitated diffusion
  - Osmosis and water movement
  - Uniporter - catalyzed transport
  - Intra cellular ion environment and membrane electric potential

- Active transport
- Epithelial transport : Receptor mediated endocytosis

**2. Cytoskeleton**

- Microtubules
- Action filaments
- Intermediate filaments
- Cilia
- Flagella

3. Concept of cell surface: Electro-kinetic properties of cell surface, their role in intercellular, inter-action in cell fusion, Cell aggregation etc.

4. Cytoplasm: Generalized structure and chemical composition (molecular basis)

**Unit - III**

- Detailed discussion on the following cytoplasmic components with special reference to the biochemical and physiological aspects.
  - Endoplasmic reticulum
  - Ribosome
  - Golgi body
  - Mitochondria
  - Lysosome
  - Peroxisome, Endosome and hydroxynosome.
  - Centrosome

**Special Paper-14 (A): Cell Biology****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**UNIT- 1**

- Nucleus : -
  - Nuclear envelope (structural and functional)
  - Structure and function of the resting nucleus
  - Nucleolus and nuclear extrusions
  - Chemistry and biosynthesis of nucleic acids
- Chromosomes
  - Structural, chemical and functional organization of the different types of chromosomes (autosomes, sex chromosomes, supernumerary chromosomes etc )
  - Chromosomal aberrations
  - Variation and evolution of chromosome numbers
  - Polyploidy
  - Polysomy

## UNIT - II

## 1. Cell cycle :

- Bacterial cell cycle
- Eukaryotic cell cycle G1 S, G2 and M phase
- Cell cycle check point
- Cyclin dependent kinase (cdks) and cyclins (cell cycle's engine)
- The cell cycle and cancer
- Meiotic cell division
- Dynamics of chromosome movement during cell division.
- Role of proteolysis in cell cycle.
- Mitotic poisons and their action

## I. Gametogenesis:

- Cytological, cytochemical and endocrinological study on the developing male and female germ cells
- Physiology of ovum and spermatozoon
- Physiology of the union of gametes and the acrosome reaction

## UNIT- III

## 2. Cell communication

- Introduction
- General principles
- G-Protein
- Protein kinase and protein phosphatase
- Signal transduction in diseases and immunity

## 3. Cell signaling

- Signaling molecules
- Steroids receptor super family (Cytoplasmic receptor)
- Functions of cell surface receptor
- Intra cellular signal transduction
- MAP kinase pathway
- JAK / STAT pathway

## Practical work based on Special paper Cell Biology 13 &amp; 14 A

## 1. Handling and operation of following apparatus and instruments:

- Phase contrast microscope, Microtome
- Electrophoretic, chromatographic and electrophysiological equipments

- Study of stained preparations of mitochondria and golgi bodies under the light microscope
- Study of germ cells; smear preparation of spermatozoa from vas deferens (vital staining) and permanent of a single ovum
- Biochemical estimations of the following in various tissues:
  - Lipids: lecithin, cephalin & cholesterol
  - Carbohydrates: Glycogen
  - Proteins
  - Amino Acids: chromatographic and Electrophoretic separation
  - Ascorbic Acid
- Study of unfixed materials
  - Unstained and live animal tissue: by phase contrast microscopy

b. Freeze- substitution and processing of treated material.

c. Demonstration of bioelectric potentials, Oscillographic demonstration of nerve action potential.

Note - (i) Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.

(ii) External features and anatomy should be studied preferably by digital techniques and the alternatives whenever live animal is studied it should be either pest or culturable species without painning them.

(iii) Those institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/ slides/ models/ photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimen with the help of charts/ slides / models / photographs and digital alternatives/ and visit of students to already established museums.

## Marks Distribution Special Paper (A) : Cell biology

(Duration: Four hours)

## Scheme of Practical Examination &amp; Distribution of Marks.

|   |          |
|---|----------|
| a. Bio chemical estimation  | 8 Marks  |
| b. Light microscopic preparation of mitochondria/ golgi bodies /spermatozoo/single ovum | 8 Marks  |
| c. Identification and comment on spots (eight)  | 24 Marks |
| d. Viva-voce  | 5 Marks  |
| e. Class record   | 5 Marks  |
| Total   | 50 Marks |

## Special Paper 13(B): Environmental Biology

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

## Unit-I

Impact of environment at cellular level: Cellular interaction with environment.

- Basic Metabolic rate and body size
- Concept of Homeostasis. Metabolism and climatic adaptations:
- Hibernation and aestivation. Poikilotherms and Homeotherms. Asphyxic responses.



1. Response to temperature and pressure. Haematological changes. Thermal properties of water and survival limits. Acclimatization.
2. Green house gases
  - a) Global warming,
  - b) Climatic change and factors responsible,
  - c) Ozone depletion, impacts of ozone depletion.
  - d) Acid rain and its adverse impacts, mitigation methods against acid rain.

**Unit-II**

1. A detailed study of different ecosystems: Biotic and abiotic components and their interrelationships, productivity
2. Terrestrial Ecosystems:
  - a) Grasslands. Including grazing lands
  - b) Forests: Characteristic of alpine, temperate & tropical forests, Stratification, High altitude with special reference to Himalayan Ecology
  - c) Deserts: Types and ecological attributes of desert biota
  - d) Taiga: Extent and ecological peculiarities
  - e) Tundra: Extent and ecological peculiarities

**Unit-III**

3. Aquatic Ecosystems (zones and adaptations):
  - a) Fresh water: Lakes (lacustrine) and rivers (riverine)
  - b) Wetland: Sunderban (Estuarine), Kooladeo (Fresh water) and Sambhar lake (Salt water)
  - c) Estuaries: Chilka, Kerala backwaters
  - d) Marine zonation animals and adaptations

Special Paper 14(B): Environmental Biology

Time: 3 Hours

Max. Marks: 50

**Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Natural Resources: Renewable and non-renewable natural resources.

- a) Forest: Use and over exploitation of forests, forest products, major and minor products of both animal and plant origin, Timber extraction
- b) Land: Land degradation. Landslides. Soil erosion and desertification
- c) Water: Use and over utilizations of surface and ground water. Floods, Drought, Dams: benefits and problems. Water management and conservation

- d) Mineral: Use and exploitation. Environmental effect of extracting and using mineral resources
- e) Food: World food problem. Effect of modern agriculture and over-grazing
- f) Energy: Conventional (Coal, Oil, natural gas and oil shale) and non-conventional (solar, wind, geothermal, hydro, biomass, biogas, tidal, hydrogen, nuclear energy from waste) energy resources. Energy crisis. Alternate energy sources

2. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable life.

**Unit-II**

1. Habitat conservation:

- a) Destruction, fragmentation, degradation, causes, consequences and conservation of different types of habitats.

2. Biodiversity conservation:

- a) The richness of biodiversity and the importance of biodiversity (Direct and indirect values)
- b) Reasons for high species diversity in tropics, biodiversity of India
- c) Loss of biodiversity and causes of extinction.
- d) Endemism, keystone species and keystone resources
- e) Exotic species and invasive species, disease and over exploitation.
- f) Threatened biodiversity, IUCN classification of endangered species, red data book

3. Basic knowledge of National and international organisations.

- a) MoEF, ZSI, WH, BNHS
- b) Zoo Authority of India, Salem Ali centre of ornithology and natural history (SACONH).
- c) Environmental information system (ENVIS), Indira Gandhi Conservation Monitoring Centre (IGCMC)
- d) The animal welfare board of India, Centre for environment education
- e) TRAFFIC, CITIES, WWF, UNEP
- f) World Heritage and biodiversity convention
- g) Convention on biological diversity (CBD)
- h) Ramsar (wetlands) convention and hot spots

**Unit-III**

1. Pollution (Sampling, monitoring, sources, effect and control)

- a) Water
- b) Air
- c) Land
- d) Thermal
- e) Noise
- f) Radiation

2. Environment impact assessment (EIA): Aims and objectives. Environment Management Systems- ISO- 14000 standards. Cost benefit analysis of environmental protection incorporating, environmental costs and benefits of designing projects.
3. Environment and health:

- a) Urban health problems. Impact of urbanisation stress, health status and health problem.  
 b) Rural health problem. Development and displacement of rural communities. Ethical and socio economic problems. Disappearing culture and traditions and their impact on environment.

## Paper 15

## Practical Work based on Special Paper 13 &amp; 14(B)

## Environmental Biology

1. Identification and writing comments on commercially important freshwater weeds, nets, boat models, hapas, limnological instruments and slides of dominant planktons.
  2. Water quality analysis (Physico-chemical parameters)
    - a. Temperature
    - b. pH
    - c. Dissolved Oxygen
    - d. Acidity
    - e. Hardness
    - f. Alkalinity
    - g. Chloride
    - h. Sulphates
    - i. Total and dissolved solids
    - j. BOD
    - k. COD
  3. Bioassays of polluted waters using fish or other aquatic organisms, statistical analysis of ecological data.
  4. Determination of  $LC_{50}$  (in fish) and  $LD_{50}$  (in mice) of any toxicant
- Note - (i) Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.  
 (ii) External features and anatomy should be studied preferably by digital techniques and the alternatives whenever live animal is studied it should be either pest or culturable species without painning them.  
 (iii) Those institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/ slides/ models/ photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimen with the help of charts/ slides / models / photographs and digital alternatives/ and visit of students to already established museums.

## Scheme of Practical Examination &amp; Distribution of Marks.

(Duration : Four hours)

|  |          |
|--|----------|
| a. Identification & comment on weeds/models/instruments                    | 10 Marks |
| b. Water quality analysis  | 10 Marks |
| c. Statistical method /Bioassay method/ Determination of $LD_{50}/LC_{50}$ | 10 Marks |
| d. Project Report  | 10 Marks |
| e. Viva  | 5 Marks  |
| f. Class Record  | 5 Marks  |
| Total 50 Marks   |          |

## Special Paper 13(C) : Entomology

Max. Marks: 50

Time: 3 Hours

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

## Unit-I

1. General Classification of insects upto orders and sub order.

General studies and economic importance of selected super families and families of the following orders:

- a) Protura
- b) Collembola
- c) Thysanura
- d) Diplura
- e) Orthoptera
- f) Isoptera.

## Unit-II

1. Detailed classification of important and selected super families and families of the following orders of economic importance:

- a) Hymenoptera
- b) Coleoptera
- c) Homoptera
- d) Lepidoptera
- e) Diptera.

## Unit-III

1. The Insect Externally- Insect head, thorax, abdomen and their appendages
2. Integument.
3. The Insect Internally- Detailed study of
  - a) The Digestive system
  - b) The Circulatory system
  - c) The Respiratory system
  - d) The Excretory system
  - e) The Muscular system
  - f) The Nervous system
  - g) The Endocrine system
  - h) The Reproductive system.

## Special Paper-14(C) - Entomology

Max. Marks: 50

Time: 3 Hours

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit- I**

1. The insect Internally-
  - Sense organs
  - Sound and light producing organs.
2. Social life in Isoptera and Hymenoptera
  - a) Caste determination in social insects A general idea of fossil insects; Evolution of insects
  - b) Life cycle of aphids.

**Unit- II**

1. General idea of damage caused by pests.
2. Principal methods of pest control including IPM.
  - a) Insecticide- their chief type, Modes of action and methods of application
  - b) A general idea of appliances used in the application of insecticide and their safe handling.

**Unit- II**

1. A detailed study and knowledge of
  - a) chemosterilants, attractants, repellants
  - b) Pheromones, growth regulators and other compounds.
2. Development of resistance to chemicals.

**Paper 15****PRACTICAL BASED ON PAPER 13 & 14 (C) ENTOMOLOGY**

1. Taxonomic study of all Insects prescribed in syllabus
2. Identification of insects from various orders prescribed for study in the syllabus
3. Permanent preparations: wings, mouth parts, antennae, legs, spiracles etc of insects, sting apparatus of the honey bee. Other possible mounting can be done
4. Dissections of grasshopper, house cricket, honey bee, wasp, bug, butterfly, house fly, beetle to study important features of :
  - a) Digestive
  - b) Circulatory
  - c) Respiratory
  - d) Excretory
  - e) nervous
  - f) reproductive
  - g) neuro- endocrine systems

Note- (i) Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.

(ii) External features and anatomy should be studied preferably by digital techniques and the alternatives whenever live animal is studied it should be either pest or culturable species without painning them.

(iii) Those institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/ slides/ models/ photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimen with the help of charts/ slides / models / photographs and digital alternatives/ and visit of students to already established museums.

**Marks Distribution for Entomology Practical Examination**

| Duration 4 hours                                    | Total marks 50        |
|---|-----------------------|
| a) Major Dissection                                 | 10 marks              |
| b) Minor Dissection                                 | 5 marks               |
| c) Permanent preparation                            | 10 marks              |
| d) Identification of 5 insects using taxonomic keys | 15 marks              |
| e) Viva voce  | 05 marks              |
| f) Class Record                                     | 05 marks              |
|   | <b>Total 50 marks</b> |

**Special Paper 13(D): Fish Biology****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit- I**

1. General Characters, Evolution and Phylogeny of fishes
2. Study of Origin and adaptive radiations of various groups
3. General account and phylogenetic significance of:
  - a) Ostracoderms
  - b) Placoderms
4. Classification of fishes, with distinguishing characters of principal sub-divisions-
  - Elasmobranchs
  - Teleostei
  - Holocephali
  - Dipnoi

**Unit- II**

1. Ichthyogeography- Geographical distribution of fishes in the world:
  - a) Palearctic Realm
  - b) Oriental Realm



- c) Ethiopian Realm
  - d) Nearctic Realm
  - e) Neotropical Realm
  - f) Australian Realm
2. Body form and locomotion of fishes- General principles and methods
    - a) Functioning, Types and modes of locomotion
  3. Integumentary System of fishes, Exoskeleton: Skin and Scales- Origin, derivatives and uses of Scales

**Unit- III**

1. Structure, modification and functions of fins in various types of fishes
2. Theories of origin of median and paired fins
3. Types of endoskeleton of fishes:
  - a) Axial Endoskeleton
  - b) Appendicular Endoskeleton
4. Musculature of fishes

**Special Paper 14(D): Fish Biology****Max. Marks: 50****Time: 3 Hours****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit- I**

1. Food and feeding habits of fishes
2. Alimentary canal of fishes
3. Physiology of digestion.
4. Blood vascular system and circulation of blood.
5. Respiratory organs, physiology of respiration and regulation of breathing organs
6. Air breathing organs.

**Unit -II**

1. Structure, function and physiology of swim bladder.
2. Weberian apparatus.
3. Excretory organs found in fishes
4. Physiology of excretion
5. Osmo-regulation in fishes

**Unit- III**

1. Nervous system and sense organs -functions and physiology
2. Endocrine Glands
3. Hormones and reproductive behaviour.
4. Gonads, reproduction, development and hatching
5. Viviparity

**Paper 15****Practical work based on Special Paper Fish Biology**

1. Taxonomy: Study of various fishes upto species level
2. Complete anatomy of a teleost, represented by Wallago: External features, general viscera, including the urino-genital organs, Jaw and lateral musculature, including the nerve supply. Afferent and Efferent branchial blood vessels. Brain and cranial nerves; eye muscles and their innervations; membranous labyrinth; Weberian ossicles- swim bladder connection, dry and alizarine preparations of the skeleton and its study.
2. Dissection of the head of any flat fish (pleuronecti forms) with reference to its asymmetry.
3. Dissection of the air-breathing organs in Anabas, Clarias, Channa, and Heteropneuste, showing the blood supply whenever possible.
4. External features, Afferent and Efferent branchial blood vessels, cranial nerves; membranous labyrinth of dasytis or any skate or ray.
5. Permanent preparations and study of Ampulla of Lorenzini; dermal and pharyngeal denticles, cycloid and ctenoid scales.

**Note -** (i) Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.

(ii) External features and anatomy should be studied preferably by digital techniques and the alternatives whenever live animal is studied it should be either pest or culturable species without painning them.

(iii) Those institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/ slides/ models/ photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimen with the help of charts/ slides / models / photographs and digital alternatives/ and visit of students to already established museums.

**Marks Distribution For Special Paper (D): Fish Biology****(Duration: Four hours)****Scheme of Practical Examination & Distribution of Marks.**

|  |          |
|--|----------|
| 1. Major dissection                            | 10Marks  |
| 2. Minor dissection/ Permanent Preparation     | 6 marks  |
| 3. Identification and comment on spots (eight) | 24 Marks |
| 4. Viva-voce                                   | 5 Marks  |
| 5. Class record                                | 5 Marks  |
| <b>Total 50 Marks</b>                          |          |

**SPECIAL PAPER-13(E) MOLECULAR DEVELOPMENTAL BIOLOGY****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least



one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit- I**

1. Historical review of main trends and thoughts in embryology;
  - a) Concept of Embryology and Developmental biology.
  - b) Theoretical and experimental embryology.
  - c) Ontogenic development and embryology.
2. Importance of Developmental Biology in modern biomedical sciences.
3. Meiosis and significance of sexual reproduction.
4. Reproductive cycles and their hormonal control.
5. Control of ovulation and induced breeding.

**Unit- II**

1. **Gametogenesis** : Molecular aspects of Spermatogenesis and Oogenesis.
  - a) Regulation of multiplication and maturation.
  - b) Active transportation during oocyte development.
2. Molecular aspect of vitellogenesis, maturation of oocyte.
  - a) Structure and biochemistry of egg and molecular changes during maturation.
  - b) Nuclear activity during the growth of oocyte and organization of egg cytoplasm.
3. **Fertilization** : Recognition of egg and sperm, gamete binding and recognition in mammals.
  - a) Reaction of spermatozoa, Sperm mortality
  - b) Capacitation
  - c) Acrosome reaction
  - d) Gamete fusion and Prevention of polyspermy.
4. Reaction of egg, activation of egg metabolism, molecular regulation of development, rearrangement of egg cytoplasm, cortical reaction, preparation for cleavage.

**Unit- III**

1. Comparative account of cleavage in insects, frogs, chick and mammals: Cleavage patterns and their control.
2. Chemical changes during cleavage
  - a) Role of egg cortex, morphogenetic gradients in egg cytoplasm
  - b) Manifestation of maternal genes during cleavage.
3. Mechanism of cleavage, Cleavage cycle, Maturation promoting factors.
4. Role of cytoplasm and nucleus during early development
5. Mechanism of gastrulation, morphogenetic movements, selective.

**Paper-14 (E) Molecular Developmental Biology (Special Paper)**

Time: 3 Hours

Max. Marks: 50

**Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Affinities of cells as a determining factor in cellular rearrangements
  - a) Morphogenetic movements in epithelia
  - b) Morphogenetic movements in mesenchyme
  - c) Mechanism of changes in shape of cell during morphogenesis, general metabolism during gastrulation
2. Gene activity during gastrulation
  - a) Involvement of parental genes in development
  - b) Comparative account of gastrulation in sea urchin, amphioxus, fish, amphibians, bird and mammal.
3. Fate map, methods of their construction and their utility
  - a) Comparative topographical relationship of the presumptive areas in early embryos of amphioxus, fishes, amphibians and birds.

**Unit -II**

1. **Genes, Development and Related Techniques**: The embryological origin of gene theory, incidences of genomic equivalence
  - a) Amphibian cloning, restriction of nuclear potency and concept of pluripotency of somatic cells
  - b) Concept of totipotency
  - c) Steward's experiment.
2. **Differential Gene Regulation**: Differential gene regulation in *E. coli*
  - a) The concept of differential gene expression in insect model
  - b) Nucleic acid hybridization techniques, cloning from genomic DNA.
3. DNA hybridization within and across the species
  - a) DNA sequencing techniques, sequence search, alignment and homologies
  - b) Analyzing mRNA through cDNA libraries.

**Unit- III**

1. RNA localization techniques, finding rare message by PCR, determining the function of gene, determining the functions of message
2. Cellular basis of morphogenesis: Differential cell affinity, the molecular basis of cell-cell adhesion, cell adhesion molecules.
3. Molecular regulators of development, molecular basis of migrational specificity, molecular basis of differential substrate specificity.

4. Differential gene function during development, chromosomal puffing; differential synthesis and utilization of various types of RNA during embryogenesis.

## Paper 15

**PRACTICAL WORK BASED ON PAPER 13 (E) & 14 (E)**  
**MOLECULAR DEVELOPMENTAL BIOLOGY**

1. Study of gametes, and various types and patterns of cleavage.
2. Early development in frog / toad.
3. Study of living embryos of the chick after 3 to 12 days of incubation.
4. Demonstration of cell death by vital staining.
5. Study of blood circulation in tail tip of amphibian larvae.
6. Study of Fluorosis during the development of amphibians.
7. Study of metamorphic stages of anuran.
8. Regeneration studies on amphibian tadpole (tail and limb) using digital techniques. Studies on the effect of retinoids on pattern formation during limb and tail regeneration using digital techniques.
9. Development of organs as chorio-allantoic grafts on chick embryos.
10. Permanent mounting of chick embryos.
11. Preparation and study of serial sections of successive embryonic stages.
12. Staging of tetrapod embryos in one animal species.
13. Effect of hormones on metamorphosis in insects by ligature experiments.
14. Effect of hormones on metamorphosis in anurans.
15. Explain culture of chick embryos on agar.

- Note -** (i) Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.  
(ii) External features and anatomy should be studied preferably by digital techniques and the alternatives whenever live animal is studied it should be either pest or culturable species without painning them.  
(iii) Those institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/ slides/ models/ photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimen with the help of charts/ slides / models / photographs and digital alternatives/ and visit of students to already established museums.

**Marks Distribution for Molecular Developmental Biology**

| Duration | Four Hours   | Max-50 marks          |
|----------|--|-----------------------|
| 1.       | Exercise on Living embryos/Exercise on Teratology  | 5 Marks               |
| 2.       | Exercise on Cell Death/Exercise on metamorphosis   | 5 Marks               |
| 3.       | Exercise on blood circulation in tail tip of amphibian larvae /Exercise on effects of fluorosis during development | 5 Marks               |
| 4.       | Permanent mounting   | 5 Marks               |
| 5.       | Identification and comments on Spots( four)  | 10 Marks              |
| 6.       | Project Report   | 10 Marks              |
| 7.       | Viva-Voce  | 5 Marks               |
| 8.       | Class Record Viva-Voce   | 5 Marks               |
|          |  | <b>Total 50 Marks</b> |

## Suggested Readings:

- de Beer, S.G. Embryos and Ancestors. Clarendon Press, Oxford.
- Barbiur, T. Reptiles and Amphibians: Their habits and Adaptations. Hongton Miffm Co., New York.
- Kingsely Nobol, G. The Biology of the Amphibia. Dover Publications, New York.
- Gilbert, S.F. Developmental Biology, Sinauer Associates Inc., Massachusetts. 4<sup>th</sup> Edition.
- Walbot, V. And Holder, N. Developmental Biology, Random House New York
- Saunders, J.W. Developmental Biology: Patterns, Problems and Principles. Macmillan Publishing Comp. Inc. New York
- Balinsky, B.I. An Introduction to Embryology Holt-Saunders International Editions.
- Wolpert, L. Principles of Development. Oxford Univ. Press.
- Malacinski, G.M. Developmental Genetics of higher organisms- a primer in Developmental Biology. Collier Macmillan Publisher London
- O'Rahilly, R. and Muller, F. Human Embryology and Teratology, John Willey and Sons
- Goss, R. Principles of Regeneration. Academic Press New York.
- Schmidt, A.J. Cellular Biology of Vertebrate Regeneration and Repair. The University of Chicago Press

**Paper-13 (F) Endocrinology (Special Paper)**

**Time: 3 Hours**

**Note:**

**Max. Marks: 50**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C  
Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)  
Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)  
Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

## Unit- I

1. Historical background. "Scope and status" of endocrinology
2. Study of the following major endocrine glands of vertebrates. Pituitary; General, developmental and comparative anatomy,
3. Functional cytology of the pituitary gland and mammalian, and sub-mammalian vertebrates, adenohipophyseal hormones their chemistry and physiology.
4. Chromatophore regulation among vertebrates; neurohormonal peptides; their chemistry and phyletic distribution; formation, storage, release and transport of neurohipophyseal principles; effects of hypophysectomy pituitary stalk secretion and transplantation.

## Unit- II

1. Thyroid: General developmental and comparative anatomy, evolution of thyroidal function; biochemistry of thyroid hormones.
2. Biological actions of thyroid hormones and their interrelationship with other endocrine secretion, effects of thyroidectomy; calcitonin, its chemistry and physiology
3. Parathyroid: General, developmental and comparative anatomy; biochemistry and physiology of the parathyroid hormone; effects of parathyroidectomy.

## Unit- III

1. Pancreatic islets: General developmental and comparative anatomy; biochemistry and physiology of insulin and glucagon; effects of pancreatomy
2. Adrenal: General development and comparative anatomy; chromaffin tissue; biochemistry and physiology of catecholamines.
3. The sympathetic - chromaffin complex steroideogenic tissue; structure and nomenclature of steroid hormones, effects of adrenalectomy

## Paper-14 (F) Endocrinology (Special Paper)

Time: 3 Hours

Max. Marks: 50

## Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

## Unit- I

1. Pineal: General development and comparative anatomy; biochemistry and physiology, the pineal principles.
2. Chemical messenger : Mechanism of hormone action.
  1. Endocrine integration : Diffuse effects of hormones: neoplastic growth; migration in birds and fishes; bird plumage, hibernation; osmoregulation; blood pressure regulation.
  2. Vertebrate neuroendocrinology : Ultrastructure and function of the neuro secretory cell, hypothalamo-hypophyseal relationship.

## Unit- II

1. Hypothalamus in relation to higher nervous centers, other neuro-secretory systems in vertebrates; the urophysis, the subcommisural organ and the pineal complex.
2. Vertebrate neuroendocrinology : Anatomy and physiology of the endocrine and neuro endocrine systems of Annelida , Arthropoda.
3. Vertebrate neuroendocrinology : Anatomy and physiology of the endocrine and neuro endocrine systems of Mollusca and Echinodermata

## Unit- III

1. Medical specialty of endocrinology- Involves the diagnostic evaluation of a wide variety , symptoms and variations .long-term management of disorders of deficiency or excess hormones.
2. Secretions and response to hormones of different organ system mainly brain, lungs, heart, intestine, skin, and the kidney, and the clinical specialty of endocrinology focuses.
3. Endocrine disorders - chronic diseases , diabetes mellitus, hypothyroidism , metabolic syndrome and care. understanding the patient at the personal and social level ,molecular, and the physician-patient relationship Endocrinologists are specialists

## Paper 15

## PRACTICAL WORK BASED ON ENDOCRINOLOGY PAPER 13 &amp; 14 (F)

1. Dissection and gross examination of various endocrine glands of representative vertebrates.
2. Microscopical study of various endocrine glands of representative vertebrates through micro-technical procedure.
3. Study of the estrous cycle in mouse or rat by the vaginal smear technique.
4. Surgical procedures: castration, ovariectomy, adrenalectomy, thyroidectomy and hypophysectomy.
5. Bioassays for estimations, androgens and anti-estrogens, the Aschiem-Zondek pregnancy test.

## Note :

- (i) Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.
- (ii) External features and anatomy should be studied preferably by digital techniques and the alternatives. Whenever live animal is studied it should be either pest or culturable species without painning them.
- (iii) Those Institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts /slides / models / photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their' Department should provide learning related to Zoological specimens with the help of chart / slides / models /photographs and digital alternatives/ and visit of students to already established museums.

Semester-III  
( ENDOCRINOLOGY)

## Scheme of Practical Examination &amp; Distribution of Marks

(Duration: Four hours)

|  | Max-50 marks |
|--|--------------|
| 1. Exercise based on dissection              | 5 Marks      |
| 2. Exercise based on microscopic observation | 10 Marks     |
| 3. Exercise based on surgical procedure      | 5 Marks      |
| 4. Exercise based preparation of chromosome  | 5 Marks      |
| 5. Exercise based Biochemistry               | 5 Marks      |
| 6. Project Report                            | 10 Marks     |
| 7. Viva-voce                                 | 5 Marks      |
| 8. Class Record                              | 5 Marks      |
| Total 50Marks                                |              |



**SEMESTER -IV****Paper-16 Ecology (Compulsory)****Max. Marks: 50****Time: 3 Hours****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit - I**

1. Introduction to ecology
2. Evolutionary ecology
3. Environmental concepts – laws and limiting factors
4. Ecological models.
5. Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure. Competition and coexistence, intra-specific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions.

**Unit-II**

1. Nature of ecosystem, production, food webs, energy flow through ecosystem.
2. Biogeochemical cycles
3. Resilience of ecosystem
4. Ecosystem management.
5. The biosphere, biomes and impact of climate on biomes.

**Unit-III**

1. Environmental Stresses and their management
2. Global climatic pattern
3. Global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations.
4. Major classes of contaminants. Uptake, biotransformation, detoxification, elimination and accumulation of toxicants.
5. Factors influencing bioaccumulation from food and trophic transfer.
6. Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Impact of chemicals on biodiversity of microbes, animals and plants. Bioindicator and biomarkers of environmental health.
7. Biodegradation and bioremediation of chemicals.

**Suggested Literature:**

1. Field Sampling: Principles and Practices in Environmental Analysis, Conklin, A.R. Jr., (2004), CRC Press.

2. Principles and Standards for Measuring Primary Production, Fahay, T.J. and Knapp, A.K., (2007), Oxford University Press, UK

3. Ecological Modeling, Grant, W.E. and Swannack, T.M., (2008), Blackwell.

4. Fundamental Processes in Ecology: An Earth system Approach, Wilkinson, D.M., (2007), Oxford University Press, UK

5. Cherrett, J.M. Ecological Concepts. Blackwell Science Publication, Oxford, U.K.

6. Elseth, B.D. and K.M. Baumgartner, population Biology, Van Nostrand Co., New York.

7. Jorgensen, S.E. Fundamentals of ecological modeling. Elsevier, New York.

8. Krebs, C.J. Ecology. Harper and Row, New York.

9. Krebs, C.J. Ecological Methodology. Harper and Row, New York.

10. Eckert, R. Animal Physiology: Mechanism and Adaptation. W.H. Freeman and Co., New York.

11. Hochachka, P.W. and G.N., Somero. Biochemical adaptation. Princeton, New Jersey.

**Paper-17 Ethology (Compulsory)****Time: 3 Hours****Note:****Max. Marks: 50**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Introduction:
  - Ethology as a branch of biology.
  - Animal psychology, classification of behavioural patterns, analysis of behaviour (ethogram)
2. Reflexes and complex behaviour.
3. Perception of the environment: mechanical, electrical, chemical, olfactory, auditory and visual.
4. Evolution and ultimate causation: Inheritance behaviour and relationships.

**Unit-II**

1. Neural and hormonal control of behaviour.
2. Genetic and environmental components in the development of behaviour.
3. Motivation: Drive, timing and interaction of drives, physiological basis of motivation, hormones and motivation, aggregation.
4. Communication: Chemical, visual, light and audio, evolution of language (primates).

**Unit-III**

1. Ecological aspects of behaviour: Habitat selection, food selection, optimal foraging theory, anti-predator defences, aggression, homing territoriality, dispersal, host parasite relations.
2. Biological rhythms: Circadian and circannual rhythms, orientation and navigation, migration of fishes, turtles and birds.



- Learning and memory: Conditioning, habituation, insight learning, association learning and reasoning.
- Reproductive behaviour. Evolution of sex and reproductive strategies, mating systems, courtship, sexual selection, parental care.
- Social behaviour: aggregations, schooling in fishes, flocking in birds, herding in mammals, group selection, kin selection, altruism, reciprocal altruism, inclusive fitness, social organization in insects and primates.

**Suggested Reading Materials:**

- Eibl-Eibesfeldt, I. Ethology. The biology of Behaviour. Holt, Rinehart & Winston, New York.
- Gould, J.L. The mechanism and Evolution of Behaviour.
- Kerbs, J.R. and N.B. Davies: Behaviourable Ecology. Blackwell, Oxford, U.K.
- Hinde, R.A. Animal Behaviour: A Synthesis of Ethology and Comparative Psychology. McGraw Hill, New York.
- Alcock, J. Animal Behaviour: An Evolutionary approach. Sinauer Assoc. Sunderland, Massachusetts, USA.
- Bradbury, J.W. and S.L. Vehrencamp. Principles of Animal Communication. Sinauer Assoc. Sunderland, Massachusetts, USA.

**Paper 20****Practical Work based on General Papers****Ecology**

- Measurement of climatic factors (atmospheric, water temperature and relative humidity)
- Measurement of water and soil pH, edaphic factors of soil, Preparation of soil extract, determination of humidity in microhabitat.
- Measurement of pH, Alkalinity, Free Carbon dioxide, Dissolved Oxygen, Chloride content, Salinity, TDS of water, temporary and permanent hardness of water, velocity of current
- Measurement of population density. Numerical problems of population density determination to be done.
- A file study of any one of the habitats to be assigned to an individual or to a group of students

**Ethology**

- Study of the process of learning in rat with the help of Animal Maize. Analysis of the results of the experiment
- Study of avoidance behavior in rat, analysis of the result of experiment.
- Imprinting in precocial birds
- Chemical communication in Earthworm
- Study of food preferences and feeding behaviour of an insect pest
- Study of phototactic response in Tribolium/ Musca/ Drosophila
- Learning by trail and error in animals using maze and jumping box
- Study of movement of fish in aquarium
- Study of courtship in birds
- Food preference in tribolium
- Pheromones in earthworms
- Study of imprinting in chicks

**Seminar** – Students have to prepare and present paper on the related topics or recent advances/research in the field of life sciences/ topics related to the

papers in the semester. Student shall prepare and use power point presentations, models, slides etc. for seminar

**Note:**

- Use of animals for dissection and practical work is subject to the conditions that these are not banned under the Wildlife Protections Act.
- Those Institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/slides/models/photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimens with the help of charts/slides/models/photographs and digital alternatives and visit of students to already established museums.

**Scheme of Practical Examination & Distribution of Marks**

| (Duration: Four hours)          | Max Marks: 50 |
|---------------------------------|---------------|
| 1. Exercise in Ecology          | 10 Marks      |
| 2. Exercise in Ethology         | 10 Marks      |
| 3. Field report /Project Report | 10 Marks      |
| 4. Seminar                      | 10 Marks      |
| 5. Viva-voce                    | 5 Marks       |
| 6. Class record                 | 5 Marks       |
| <b>Total 50 Marks</b>           |               |

**Special Paper 18(A): Cell Biology****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

**Part-A (10marks):** Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

**Part-B (10 marks):** Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

**Part-C (30 marks):** 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

- Specialized function of cytoplasmic components in a cell with special references to the molecular mechanism (Contractility, secretion, phagocytosis and pinocytosis).
- Cell and tissue culture:
  - Behavior of cells in culture.
  - Primary and established cell lines; kinetics of cell growth.
  - Natural and defined media for culture.
  - Importance of cell and tissue culture.
  - Generalized account of the mechanism of cell aggregation during development, in vitro studies.

**UNIT - II**

- Chemical basis of fixation and staining and a discussion on the following techniques-

- Freeze substitution.
- Freeze drying.
- Fresh and fixed frozen sections.
- PAS, Metachromasia, Feulgen, lipid and protein staining techniques
- Centrifugation and ultra centrifugation.
- Single, two dimensional and column chromatography.
- Intra- vital and supra vital staining
- Paper, gel and disc electrophoresis.

**UNIT - III**

- Elementary concept of the principle and theory of microscopy as exemplified by the following:
  - Phase contrast microscopy.
  - Interference microscopy.
  - Polarizing microscopy.
  - Fluorescence microscopy.
  - Electron microscopy.
  - Ultra violet microscopy.

**Special Paper 19 (A): Cell Biology****Unit-I**

- A general account of the effect of ionizing radiation at the cellular level.
- Generalized account of the mechanism of cell aggregation during development, in vitro studies.
- Role and mechanism of action of the following enzymes at the cellular level:
  - ATPase
  - Succinic dehydrogenases
  - Acid and alkaline phosphatases
  - Hyaluronidase

**Unit-II**

- Complete knowledge of the origin of following diseases:
  - Cancer
  - Glycogen storage disease
  - AIDS
  - Molecular basis of thalasemia
  - muscular dystrophy
  - cystic fibrosis
- Cellular aspects of the process of aging
- Cellular aspects of the immunity and virus-cell interaction

**Unit-III**

- Genetic analysis in cell biology
- Gene families: organization, evolution and significance
- Chemistry of gene :
- Synthesis, modification and repairing of DNA
- Environmental modulation of gene activity (stress response) stress genes and stress proteins
- Transposable genetic elements of prokaryotes and eukaryotes Gene imitation and molecular mechanism of occurrence of mutation repair mechanism.

**Paper 20****Practical work based on Special paper Cell Biology**

- Microtomy- Wax, fresh, frozen and fixed frozen sections, sectioning of gelatin embedded material
- Histo-chemical demonstration
  - Acid haematin of Baker & its modification
  - Grkamoto's method
- Cytochemical demonstration
  - Millon's reaction
  - Ninhydrin Schiff method
- Histo-cytochemical method:
  - Methyl Green Pyronin method
  - Feulgen staining
  - Periodic acid Schiff method
  - Alcian blue method
  - Bromo phenol blue method
- Histo-cytochemical staining of enzymes: Staining of alkaline and acid phosphates in kidney, liver and nervous tissue by Gomori's method and Azo dye technique.

**Semester IV****Marks Distribution Special Paper (A): Cell biology****Scheme of Practical Examination & Distribution of Marks**

| (Duration: Four hours)                   |          |
|--|----------|
| a. Exercise on histo chemical techniques | 16 Marks |
| b. Cyto chemical techniques              | 12 Marks |
| c. Microtomy                             | 12 Marks |
| d. Viva-voce                             | 5 Marks  |
| e. Class record                          | 5 Marks  |
| <b>Total 50 Marks</b>                    |          |

**Semester -IV****Paper-18 (B) Environmental Biology (Special Paper)****Max. Marks: 50****Time: 3 Hours****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

- Weather and climate
  - Atmosphere- structure and composition
  - Local winds: Sea and land breezes, Polar easterlies, Westerlies, Trade winds

- c) Indian and African Monsoon
  - d) Inversions: Thermal inversions: causes, consequences. Subsidence inversion
  - e) Clouds and their formation
2. Element and factors of climate
- a) External factors: earth's orography- Oceanic and continental influence.
  - b) Deforestation - surface albedo - snow and ice - Volcanic activity - Dust particles - Greenhouse gas concentrations
  - c) Atmosphere- ocean heat exchange- Atmospheric carbon dioxide variations- human influences
  - d) Global climate changes- causes and consequences

**Unit-II**

1. Development and evolution of ecosystems, causes and kinds of succession. Diversity and productivity in relation to stages of succession and development.
2. Urban, rural and other man made ecosystems and their impact on animal life.
  - a) Use of micro-organisms in bioremediation of soil and oil spills.
  - b) Bio- fertilizers, Rhizobium, Azotobacter, Nitrogen fixation, vermitechnology and vermicomposting.
  - c) Applications of microbes in removal of heavy metals and other contaminants from water and soil.

**Unit-III**

1. Environmental health and toxicology
  - a) Toxicants of public health (pesticides, metals, solvents, radiation)
2. Movement, distribution and fate of toxins:
  - a) Bioaccumulation
  - b) Biomagnification
  - c) Translocation of xenobiotics: absorption, biotransformation, excretion
3. Measuring toxicity (acute, sub-chronic and chronic).

**Paper-19 (B) Environmental Biology (Special Paper)**

Time: 3 Hours

Max. Marks: 50

**Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Biogeography
  - Major terrestrial biomes

- Biogeographical zones of India-
  - a) Trans Himalayan zone.
  - b) Himalayan zone
  - c) Desert zone.
  - d) Semiarid zone.
  - e) Western ghat zone.
  - f) Deccan plateau zone.
  - g) Gangetic plain zone.
  - h) North east zone.
  - i) Coastal zone.
  - j) Islands present near the shore line.

**Unit-II**

1. Environment Awareness:
  - a) Earth summits
  - b) Carbon footprint and carbon tax
  - c) Global warming, ozone layer depletion
  - d) Important dates and their significance.
2. Impact of tourism related activities on Environment
  - a) Basic principles of ecotourism
  - b) Island ecology and tourism
  - c) Pollution related to tourism- solid and liquid waste from tourist destination
3. Environmental protection movements- Global, national and local, historical. Present social pressure group agencies like Chipko movement, Narmada bachao.
4. Procedure and methodologies of Environmental Impacts Assessment, Environmental clearance procedure with particular reference to India.

**Unit-III**

1. Types of water resources, types of water pollutants, sources of water pollutants, adverse impacts of water pollution on plants and animals, water standards for different kinds of uses. Management of water resources.
2. Water Borne and Water Related Diseases. Diseases caused due to fluoride (skeletal and non skeletal fluorosis), nitrate, hardness and pH of water and heavy metals. Control of water borne diseases.
3. Energy And Environment
  - a) Various method of energy (power)production, coal based and gas based thermal power generation and related impacts on environment.
  - b) Hydropower potential in our country, methods of hydropower generation, Geothermal power in country.
4. Wildlife
  - a) History
  - b) Causes of depletion
  - c) Techniques of studying - Radiometer, photographic identification and remote sensing
  - d) Wildlife of India- Wild life-schedules, Ecozones, National parks, Sanctuaries, Reserves

- e) Management, special protection programs (Tiger, Rhino, Lion tailed macaque, Elephant)
- f) Wildlife protection act 1972, its amendments and implementation.

## Paper 20

## Practical Work based on Special Paper (B) Environmental Biology

1. Microscopic examination of water  
Indicators of pollution, planktons, benthic and littoral fauna and flora
1. Soil/Sediment analysis
  - a. EC
  - b. pH
  - c. Alkalinity
  - d. Organic matter
  - e. Texture
  - f. Salinity
2. Air quality monitoring
  - a. Setttable matter
  - b. Suspended particulate matter
3. Write characteristics of different biomes and mark their location on India's map.
4. Determination of the concentration of following insecticides in water:
  - a) DDT
  - b) Methyl Parathion
5. Field trip to any of the following habitats:
  - a. Forest; Wild life sanctuary
  - b. Fresh water habitat
  - c. Marine habitat
  - d. Semi arid habitat
  - e. Desert

(Students are expected to give complete Ecological Report of the trip including ecosystem structures, indicators and estimation of environmental degradation, if any.)

## Semester IV

Marks Distribution Special Paper (B): Environmental Biology  
Scheme of Practical Examination & Distribution of Marks  
(Duration: Four hours)

|   |          |
|---|----------|
| 1. Microscopic Examination of water/Sampling Method | 10 Marks |
| 2. Soil Analysis                                    | 10 Marks |
| 3. Air Quality Monitoring/Pollution Study           | 10 Marks |
| 4. Project Report/Field Trip                        | 10 Marks |
| 5. Viva-voce  | 5 Marks  |
| 6. Class record                                     | 5 Marks  |
| Total : 50 Marks                                    |          |

## Paper-18( C ) Entomology (Special Paper)

Max. Marks: 50

Time: 3 Hours

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

## Unit-I

1. Life history, damage caused and control of major pests of the main crops:  
Wheat, paddy, maize, jowar, millet, sugar cane, cotton and oil seeds
2. A study of pests of stored grains
3. Ways and means of storage of food grains

## Unit- II

1. A general idea of plant protection organization in India.
2. Timber and fruits plant (Apple, mango, guava) pest and tools as sprayer to use the pesticides on these.
3. Beneficial insects : Silkworm, honey bee and Lac insect; and industries related to them.

## Unit - III

1. Important insects used in biological control.
2. Ecology: Effect of physical factors, Intra specific and inter-specific relations, dynamics of population.
3. Embryology: Embryonic and post embryonic development; Diapause.

## Semester -IV

## Paper-19(C) Entomology (Special Paper)

Time: 3 Hours

Note:

Max. Marks: 50

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

## Unit-I

1. Culture of Insect : Honey bee, Silk moth and Lac insect
2. Insect behaviour- Rhythms, locating, food and initiating feeding, locating mates and copulation oviposition, orientation, migration, protective behavior, concealing, coloration, revealing coloration, mimicry.

## Unit-II

1. Social life- Isoptera (termites) and hymenoptera ( Social wasps Ants social Bees)



2. Biological Control- Parasitism by insect: ectoparasites and endoparasites of Invertebrates, endoparasites of vertebrates, social parasites.

**Unit-III**

1. Pest control- principles and practice- Introduction, types of crop pest (Key pests, occasional pest and potential pest).
2. Pest control procedure- The main options - cultural control
3. Crop rotation, Time of sowing, Irrigation cultivation, Cultural control in perennial crops and in pastures.
4. Antagonistic, additive and synergistic effect of pesticides, Lethal dose 50% concentration, acute toxicity, Safe concentration and other level of toxicity.

**Suggested reading materials-**

- Fundamental of Entomology ( Richard J.Elzingz)
- Applied Entomology (P.G Fenemore, Alka Prakash)
- Applied Entomology (Manju Yadav)
- A text Book of Entomology (R. Mathur)
- General text book of entomology (Imms)
- Text Book of Entomology Insects ( Packard A.S.)
- General Entomology Entomology ( John R. Meyer)

**Paper 20****PRACTICAL BASED ON PAPER 18 & 19 ( C) ENTOMOLOGY**

1. Knowledge and use of equipment for the collection and preservation of insects; insect net.
2. Collection and preservation of insects and their different stages.
  - a. Killing bottle, spreading board, insect box, device for inflating larva, light trap, etc.
3. Collection and study of seasonal insects, nocturnal insects, aquatic insects, crop pest stored grain pest and insects of medical and veterinary importance.
4. Collection and preservation of insects and their different stages.
- 5.
6. Familiarity with techniques and appliances of applying insecticides, experiments for testing the insecticides.
7. Knowledge of rearing insects and of maintaining the insectary.
8. Micro technical procedures.
9. A tour to visit important centre of entomological studies.

Note - (i) Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.  
 (ii) External features and anatomy should be studied preferably by digital techniques and the alternatives whenever live animal is studied it should be either pest or culturable species without painning them.  
 (iii) Those institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts/ slides/ models/ photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to zoological specimen with the help of charts/ slides / models / photographs and digital alternatives/ and visit of students to al-

ready established museums.

| Distribution of Marks for Entomology Practical Examination 2017 |                |
|---|----------------|
| Duration 4 hours  | Total marks 50 |
| a) Microtomy  | 12 marks       |
| b) Identification and comment on spots (six)                    | 18 marks       |
| c) Study of Insecticides and Insectary                          | 5 marks        |
| d) Study Tour   | 5 marks        |
| e) Viva voce  | 5 marks        |
| f) Class Record   | 5 marks        |
| <b>Total 50 Marks</b>   |                |

**Special paper 18 (D): Fish Biology**

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

**Unit- I**

1. A general survey of world fisheries, survey of principal fisheries of India
  - a) Fresh water
  - b) Estuarine
  - c) Marine
2. A study of plankton in relation to fisheries: Definition, origin, Occurrence, Types and significance
3. Fish Pathology: Various kinds of diseases of fishes (Symptoms, Etiology and Treatment):
  - a. Nutritional Diseases
  - b. Intrinsic diseases
  - c. Disease caused by Pathogens and Parasites

**Unit- II**

1. Bio-chemical composition of fish- as food.
2. By-products of fishing industry; with special reference to India.
3. Study of Bioluminescence in fishes: Occurrence, Location, Categories
  - a) Structure, Regulation, Mechanism and Biological Significance of Luminescence in fishes
4. Electric organs found in fishes: Nature, Location, Structure, Types and Functions
  - a) Functioning Mechanism of Electric Organ

**Unit- II**

1. Population Dynamics: Estimation of population number and mortality rates in fishes found in fresh waters
2. Fecundity in Fishes: Eggs and life history including a generalized classification of maturity stages
3. Estimation of fish production with special reference to fresh water

4. Poisons and venoms organs in fishes
5. Sound producing organs in fishes

## Special paper 19(D): Fish Biology

Time: 3 Hours

Max. Marks: 50

## Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

## Unit -I

1. Detailed study of the biology of Indian major carps
  - a) Cat-fishes
  - b) Hilsa
  - c) Sardine
  - d) Mackerel sharks
  - e) Prawns and Oysters.
2. Pisciculture and its importance, with special reference to India:
  - a) Objectives, Types and Breeding habits of Cultivable Fishes ( With Special reference to Major Carps)
  - b) Fish Culture Programming
3. Fresh water pollution in relation to fisheries with special reference to India:
  - a) Causes, types and related Effects on fish Fauna
  - b) Types of Water pollution on the basis of Fisheries

## Unit -II

1. A brief outline on the methods of fishing in fresh waters of India:
  - a) Marine Fishing Crafts and Gears
  - b) Inland fishing Crafts and Gears
  - c) Unconventional Fishing Methods
2. Ecological factors affecting the life of fishes in marine ecosystem.
3. Survey of fish in relation to mankind.
4. Age and growth studies in fishes:
  - a) Scale Method
  - b) Otolith and Bone Method
5. Coloration in fishes: Introduction, Sources of Colours, Colour Change, Regulation and Significance

## Unit - III

1. Aquaria and their uses. Setting up and maintenance of Aquarium
2. Exotic fishes: Definition and Categories; Their role in Indian fresh waters
3. Courtship and Parental care- A general study of fish behavior
  - a) Factors responsible for Parental Care
  - b) Pattern of Parental care in Fishes

4. Migration and its causes:
  - a) Introduction, General Account and advantages of Fish Migration
  - b) Migration Behaviour of some fishes
  - c) Factors influencing Fish Migration
5. Conditions of life and Adaptations of :
  - a) Hill stream Fishes
  - b) Deep Sea Fishes

## Paper 20

## Practical work based on Special Paper 18 &amp; 19 ( D) Fish Biology

1. Micro-technical procedures: Preparation and study of serial sections of a larval fish and representative tissues and organs of fish.
2. Collection of local fishes and their identification upto the species level: Study of the available specimens.
3. Hydro-biological studies:
4. Analysis of water to determine the pH, free Carbon dioxide, dissolved oxygen, chloride, calcium, total alkalinity and total salinity.
5. Collection :Estimation and analysis of planktons.
6. Biochemical and physiological:
  - a) Estimation of glycogen in liver.
  - b) Determination of pool size or free Amino acids of muscle or blood plasma through chromatography.
  - c) Effect of Epinephrine on the chromatophores.
  - d) Induced Spawning.
7. Field studies:
 

Periodical visit to a local fishing farm of fish centre to gain first hand knowledge of its pisci cultural practices and fisherine activities.

b) A week's tour of an inland fisheries research station of pisci-culture centre.

  - a) A week's stay and work at an important marine biological or fisheries centre in the country.
  - b) Note: A record of the work done under item no. 10 has to be compulsorily submitted by each candidate.

## Marks Distribution For Special Paper (D): Fish Biology

(Duration: Four hours)

## Scheme of Practical Examination &amp; Distribution of Marks.

|   |          |
|---|----------|
| 1. Species identification using taxonomic key           | 10 Marks |
| 2. Hydro Biological/bio-chemical/physiological exercise | 10 Marks |
| 3. Microtomy  | 10 Marks |
| 4. Project Report on Field Study                        | 10 Marks |
| 5. Viva-voce  | 5 Marks  |
| 6. Class record   | 5 Marks  |

Total 50 Marks

## Paper-18(E) Molecular Developmental Biology (Special Paper)

Time: 3 Hours

Max. Marks: 50

## Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

#### Unit-I

1. Cell Differentiation: (a) Definition, Biochemical basis of differentiation
2. Structural and biochemical changes during differentiation of muscle, cartilage, vertebrate pigment cells, lens and lens fibres, and epidermis
3. The reversibility and inheritance patterns of gene activity. Control of specific gene expression. Models of cell differentiation.

#### Unit -II

1. Developmental Genetics:
  - a. Role of nucleus and cytoplasm in development
  - b. Nuclear transplantation in Amphibia
  - c. Somatic cell hybridization
2. Patterning the vertebrate body plan:
  - a) Setting up the body axes. Origin and specification of the germ layers.
  - b) Somite formation and Patterning
  - c) Role of organizer regions and neural induction

#### Unit -III

1. Development of Drosophila body plan:
  - a) Maternal genes in set up of body axis
  - b) Zygotic genes in patterning the early embryo
  - c) Segmentation-activation of the pair rule genes.
  - d) Body plan of drosophila
  - e) Segment polarity genes and compartments
  - f) Segmentation selector and homeotic genes
2. Sex determination :
  - a) Chromosomal sex determination in Mammals.
  - b) Sex determination in Drosophilla.
  - c) Environmental Sex determination.

#### Paper-19( E) Molecular Developmental Biology (Special Paper)

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

#### Unit-I

1. Normal table of development of anuran
  - a) Metamorphosis in anurans
  - b) Hormonal control of metamorphosis.
2. Abnormal Development : Abnormal Growth—Teratomas , Malignancy
3. General characteristics and properties of cancer cell. Ontogenesis and carcinogenic agents.
4. Teratology: Types of anomalies; genetic effects (pellotropism; phenocopies; analization)
5. Environmental effects, teratogenic agents, General mechanism of action of teratogenic agents.

#### Unit -II

1. Limb development and Regeneration in vertebrates: Pattern formation in the limb
2. Concept of limb field, mesenchyme-AER interactions
3. determination of limb fields by homeotic genes.
4. Regeneration of vertebrate limb- Wound healing, source of cells for regeneration; dedifferentiation, re-differentiation, pattern organization- proximo distal, dorso-ventral and antero-posterior, positional informations
5. Role of distal transformation of blastema, retinoids in regeneration enhancement of developmental potencies of cells by retinoids. Homeotic transformations, genes and regeneration.
6. Loss of ability of organ regeneration in vertebrates. Finger regeneration in mouse. Induction of regeneration in non-regenerative cases.

#### Unit -III

1. Cell tissue and organ culture: Basic requirements, design of the laboratory. Balanced salt solution; pH control; use of antibiotics. Culture media, natural and chemically defined
2. Methods of preparing cells, tissues and organs for culture *in vitro*. Contribution of cell, tissue and organ culture studies in developmental biology, medicine etc. Embryo culture techniques (New's ring technique, Auerbach's embryo culture technique)
3. Elementary knowledge about artificial fertilization and IVF techniques. Types of Infertility and Assisted Reproduction Techniques . Sperm banks, artificial insemination, preservation techniques.
4. Animal Cloning Methods and Current advancements, Amphibian cloning, restriction of nuclear potency and concept of pluripotency of somatic cells, concept of totipotency, Steward's experiment.

#### SUGGESTED READINGS:

- de Beer, S.G Embryos and Ancestors. Clarendon Press, Oxford.
- Barbiur, T. Reptiles and Amphibians: Their habits and Adaptations. Hongton Miffm Co., New York.



- Kingsley Nobel, G. The Biology of the Amphibia. Dover Publications, New York.
- Gilbert, S.F. Developmental Biology, Sinauer Associates Inc., Massachusetts. 4<sup>th</sup> Edition.
- Walbot, V. And Holder, N. Developmental Biology, Random House New York
- Saunders, J.W. Developmental Biology: Patterns, Problems and Principles. Macmillan Publishing Comp. Inc. New York
- Balinsky, B.I. An Introduction to Embryology Holt-Saunders International Editions.
- Wolpert, L. Principles of Development. Oxford Univ. Press.
- Malacinski, G.M. Developmental Genetics of Higher organisms- a primer in Developmental Biology. Collier Macmillan Publisher London
- O'Rahilly, R. and Muller, F. Human Embryology and Teratology, John Wiley and Sons
- Goss, R. Principles of Regeneration. Academic Press New York.
- Schmidt, A.J. Cellular Biology of Vertebrate Regeneration and Repair. The University of Chicago Press

**Paper 20****PRACTICAL WORK BASED ON SPECIAL PAPER 18 & 19  
MOLECULAR DEVELOPMENTAL BIOLOGY**

1. Teratological experiments on one of the species on which normal development was studied. Teratological effects of retinoid during development of heart and skeleton in mammals.
2. Molecular control of development of *Drosophila* - Expression of segmental genes during *Drosophila* development.
3. Demonstration of Imaginal discs of *Drosophila*.
4. Sound call, analysis and application in identification of amphibians species.
5. SDS-PAGE electrophoresis to study change in profiles of soluble proteins during development.
6. To study effects of known cytological markers such as actinomycin-D, tunicamycin, cyclohexamide etc. on development.
7. Aurbach's and New's ring culture techniques using chick embryos
8. Embryo lifting techniques and culture-early chick embryo.
9. Biochemical changes during development - protein, nucleic acids-semi auto analyser study.
10. T3, T4, TSH profiles during amphibian metamorphosis and comparison with mammalian development.
11. Identification of antibodies development using ELISA.
12. Demonstration of endonuclease activity of DNA fragment.
13. Biochemical changes during development - protein, nucleic acids-semi auto analyser study.

**NOTE:**

- i. Use of animals for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.
- ii. External features and anatomy should be studied preferably by digital techniques and the alternatives. Whenever live animals are studied it should be

- either pest or culturable species without painning them.
- iii. Those institutions which are already having Zoology Museum should not procure Museum Specimens now onwards and should use charts / slides / models / photographs and digital alternatives in case of need.
- iv. Those new institutions which are not having Zoology Museum in their depts should provide learning related to zoological specimens with the help of charts / slides / models / photographs and digital alternatives / and visit of students to already established museums.

**Semester-IV****Marks Distribution for Molecular Developmental Biology**

| Duration | Four Hours  | Max-50 marks |
|----------|---|--------------|
| 1.       | Exercise on T3, T4, TSH                           | 5 Marks      |
| 2.       | Exercise on culture technique using chick embryo- | 5 Marks      |
| 3.       | Exercise on molecular regulation of development   | 5 Marks      |
| 4.       | Exercise on Biochemistry                          | 5 Marks      |
| 5.       | Identification and comments on Spots( four)       | 10 Marks     |
| 6.       | Viva-Voce   | 5 Marks      |
| 7.       | Project Report-                                   | 10 Marks     |
| 8.       | Class Record                                      | 5 Marks      |

Total 50 Marks

**Paper-18 (F) Endocrinology (Special Paper)****Time: 3 Hours****Max. Marks: 50****Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts. Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

1. Historical background. "Scope and status" of endocrinology
2. Study of the following major endocrine glands of vertebrates.
  - a) Pituitary; General, developmental and comparative anatomy, Functional cytology of the pituitary gland and mammalian, and sub-mammalian vertebrates
  - b) Adenohypophyseal hormones their chemistry and physiology; chromatinophore regulation among vertebrates; neurohormonal peptides; their chemistry and phyletic distribution; formation, storage, release and transport of neurohypophyseal principles; effects of hypophysectomy pituitary stalk secretion and transplantation.
  - c) Thyroid: General developmental and comparative anatomy, evolution of thyroidal function; biochemistry of thyroid hormones; biological actions of thyroid hormones and their interrelationship with other endocrine se-



cretion, effects of thyroidectomy; calcitonin, its chemistry and physiology

**Unit-II**

- Parathyroid: General, developmental and comparative anatomy; biochemistry and physiology of the parathyroid hormone; effects of parathyroidectomy.
- Pancreatic islets: General developmental and comparative anatomy; biochemistry and physiology of insulin and glucagon; effects of pancreatotomy.
- Adrenal: General development and comparative anatomy; chromaffin tissue: biochemistry and physiology of catecholamines; the sympathetic - chromaffin complex steroidogenic tissue; structure and nomenclature of steroid hormones, effects of adrenalectomy.
- Pineal: General development and comparative anatomy; biochemistry and physiology, the pineal principles.
- Chemical messenger : Mechanism of hormone action.

**Section - C**

- Endocrine integration : Diffuse effects of hormones; neoplastic growth; migration in birds and fishes; bird plumage, hibernation; osmoregulation; blood pressure regulation.
- Vertebrate neuroendocrinology : Ultrastructure and function of the neuro secretory cell, hypothalamo-hypophyseal relationship, hypothalamus in relation to higher nervous centers, other neuro-secretory systems in vertebrates; the urophysis, the subcommisural organ and the pineal complex.
- Invertebrate neuroendocrinology : Anatomy and physiology of the endocrine and neuro endocrine systems of Annelida , Arthropoda and Mollusca.

**Paper-19 (F) Endocrinology (Special Paper)**

Time: 3 Hours

Max. Marks: 50

**Note:**

Syllabus of each paper is divided into three units. The question paper is divided into three parts, Part-A, Part-B and Part-C

Part-A (10marks): Part A is compulsory and contains 10 questions. At least three questions will be set from each unit and each question carries 1 mark. (50 words each)

Part-B (10 marks): Part B is compulsory and contains five questions, taking at least one question from each unit. Candidate is required to attempt all 5 questions. Each question carries 2 marks. (100 words each)

Part-C (30 marks): 6 questions will be set taking 2 from each unit. Candidate is required to attempt 3 questions, taking 1 from each unit. Each question carries 10 marks. (400 words each)

**Unit-I**

- Hormonal control of sex differentiation nuclear sex.
- The female reproductive system: Comparative anatomy and physiology of the mammalian and sub-mammalian ovary and sex accessory structures, ovarian hormones and their functions.
- The male reproductive system: Comparative anatomy and physiology of the mammalian and sub-mammalian testis and sex accessory structures, semen and

its biochemistry, testicular hormones and their functions

**Unit-II**

- The gonadal hypophyseal-hypothalamus relationship.
- Breeding seasons in vertebrates, evolution of viviparity, induced spawning in fish and frog.
- Endocrinology of fertilization implantation, delayed implantation, parturition and lactation.
- Placenta as an endocrine tissue foeto-placental unit.
- Functional aspects of chemical, mechanical and surgical control of male fertility in laboratory mammals and the human.
- Functional aspects of chemical, mechanical and surgical control of female fertility in laboratory mammals and the human.

**Unit-III**

- Pheromones; Control of fertility in insects.
- Prostaglandins: Types, chemistry, mechanism of action and their effects on mammalian reproduction.
- Hormonal imbalance and major endocrine disease:
  - Gigantism.
  - Acromegaly.
  - Dwarfism.
  - Addison's disease.
  - Cushing's syndrome.
  - Goitre.
  - Cryptorchidism.
  - Hypogonadism
  - Amenorrhoea.
  - Diabetes mellitus.
  - Tetany.

**Paper 20****PRACTICAL WORK BASED ON PAPERS 18 & 19 (ENDOCRINOLOGY)**

- Surgical procedures: castration, ovariectomy, adrenalectomy, thyroidectomy and hypophysectomy.
- Biochemical estimations of cholesterol content in adrenal tissue glycogen in uterine tissue.
- Sperm count.
  - Study of the sex chromatin.
- Effect of epinephrine on chromatophores in fish.
- Study of microscopic slides of endocrine and related structures.

**Note :**

- Use of animal for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.
- External features and anatomy should be studied preferably by digital techniques and the alternatives. Whenever live animal is studied it should be either pest or culturable species without painning them.

**64 / M.D.S.U. Syllabus / M.Sc. Zoology**

(iii) Those Institutions which are already having Zoology Museums should not procure Museum Specimens now onwards and should use charts / slides / models / photographs and digital alternatives in case of need. Those new institutions which are not having Zoology Museum in their Department should provide learning related to Zoological specimens with the help of chart / slides / models / photographs and digital alternatives/ and visit of students to already established museums.

**Marks Distribution for special Paper 18 & 19  
(Endocrinology)**

| <b>Duration—Four hours</b>   | <b>Max-50 marks</b> |
|--|---------------------|
| 1. Exercise based on bioassay of hormone administration effects          | 4 Marks             |
| 2. Exercise of sperm count/Effects of Epinephrine on fish chromatophores | 3 Marks             |
| 3. Quantitative estimation of fructose in given gland.                   | 4 Marks             |
| 4. Cellular identification of given gland                                | 5 Marks             |
| 5. Identification and comments on spots(Eight)                           | 24 Marks            |
| 6. Viva-voce   | 5 Marks             |
| 7. Class Record  | 5 Marks             |

Total : 50marks

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