

MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER
SYLLABUS
SCHEME OF EXAMINATION AND COURSES OF STUDY
FACULTY OF SCIENCE
M.Sc. ZOOLOGY SEMESTER SCHEME
(WITH EFFECT FROM 2019-20)

NOTICE

*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.***

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 Semester I and II; as well as separate 4 hours duration Practical Examinations for Compulsory papers (50 Marks) and Special Papers (50 Marks) in two different days in semester III and IV.
3. Each theory paper of each semester is assigned four hours per week of teaching. Practical classes are assigned 18 hours per week of teaching in each Semester. Two hours per week for seminars are assigned 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 & Paper Nomenclature	Total Marks
Semester I	
Paper -1 Taxonomy, Biodiversity and Wildlife	50
Paper -2 Cell and Molecular Biology	50
Paper -3 Genetics and Evolution	50
Paper-4 Immunology and Biotechnology	50
Paper-5 Practical	<u>100</u>
Total	300
Semester II	
Paper - 6 Structure and Function of Invertebrate	50
Paper - 7 Biochemistry	50
Paper - 8 Physiology and Endocrinology	50
Paper - 9 Developmental Biology	50
Paper- 10 Practical	<u>100</u>
Total	300
Semester III	
Paper - 11 Biology of Chordates	50
Paper - 12 Ecology	50
Paper - 13 Special Paper A/ B/ C/ D/E/F	50
Paper - 14 Special Paper A/ B/ C/ D/E/F	50
Paper- 15 Practical-I	50
Paper- 16 Practical-II	<u>50</u>
Total	300
Paper- 15 Practical-I (Based on Paper 11 & 12)	
Paper- 16 Practical-II (Based on Paper 13 & 14)	
Semester IV	
Paper - 17 Biological Techniques and Biostatistics	50

Paper - 18 Animal Behaviour	50
Paper - 19 Special Paper A/ B/ C/ D/E/F	50
Paper - 20 Special Paper A/ B/ C/ D/E/F	50
Paper- 21 Practical-I	50
Paper- 22 Practical-II	<u>50</u>
Total	300
Paper- 21 Practical-I	(Based on Paper 17 & 18)
Paper- 22 Practical-II	(Based on Paper 19 & 20)
Special Paper A- Cell and Molecular 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	

M.SC. ZOOLOGY SEMESTER-I
Paper 1- Taxonomy, Biodiversity and wild Life

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. 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. Rare, endangered or threatened species and their Conservation strategies
7. 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 with reference to animal diversity.

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 (1972), Biological Diversity Act (2002)
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 Cell and Molecular 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. Structural organization and function of intracellular organelles: (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).
2. Biomembranes: Basic structure, Transport across cell membranes, Diffusion, Osmosis (Uniports, Symports and Antiports), Ion Channels, Active Transport and Membrane Pumps, Electrical properties of biomembranes and Membrane potential.
3. Intracellular transport : Intracellular protein trafficking, Signal hypothesis.
4. Cell adhesion and communication: Tight junctions, Gap junctions, Connexins, Desmosomes and Spot desmosomes.

UNIT- II

1. Cell – Cell signaling : Second messenger system, cAMP , Cell surface receptors and intra – cellular receptors.
2. Cell Division and Cell Cycle : Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. Role of Microtubules in cell cycle, Cyclins and cyclin dependent kinases, Regulation of CDK – cyclin activity; Check points of cell cycle.
3. General Accounts of Nucleic Acids, Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). DNA Replication: Replication in prokaryotes and eukaryotes, mechanics and enzymes involved in DNA replication. DNA damage and repair mechanisms, homologous and site-specific recombination.

4. Transcription: Prokaryotic and Eukaryotic transcription, Regulatory elements and mechanism of transcription regulation. Antitermination and attenuation. Post transcriptional modifications: Capping, Poly-A tail, Splicing

UNIT-III

1. Organization of genes and chromosomes : (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).
2. C-value Paradox, Euchromatin and Heterochromatin. Human karyotype, chromosomal banding (Paris conference nomenclature). Somatic cell genetics : Cell fusion and hybrid agents, mechanism of fusion Formation of heterokaryon (Hybrid selection and chromosomal segregation). Applications of hybridoma technology.
3. Protein synthesis and processing :(Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).
4. Control of gene expression at transcription and translation level : (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

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 bology. 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-3 Genetics and Evolution

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, 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. Mendelian Principles- Dominance, segregation, independent assortment, current status
2. Concept of gene- alleles, Multiple Alleles pseudoalleles, complementation tests.
3. Extension of Mendelian Principles- Codominance incomplete dominance, gene interactions— Supplementary gene, Complementary gene, epistasis, pleiotropy, penetrance and expressivity, phenocopies, linkage and crossing over
4. Gene mapping methods- Linkage maps, tetrad analysis, mapping with molecular markers

5. Extra chromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance
6. Microbial Genetics- Methods of genetic transfer, transformation, conjugation, transduction, fine structure analysis of genes.
7. Human genetics, Pedigree analysis, Karyotypes, lod score for linkage testing, Genetic disorders (Human)

Unit-II

(A)

1. Quantitative genetics- Polygenic inheritance, heritability and its measurement, QTL mapping.
2. Mutations & mutagenic agents- Types, causes and detections, mutant types, lethal, biochemical, loss of function, gain of function, germinal versus somatic mutation, insertional mutagenesis.
3. Structural and numerical alterations in chromosomes- deletion, duplication, inversion, translocation, ploidy & their genetic implications.

(B)

4. Emergence of evolutionary thought
 - Lamarckism and neo- Lamarckism
 - Darwinism- concept of variation, adaptation, struggle and fitness, natural selection.
 - Mendelism, spontaneity of mutation
 - Modern evolutionary synthesis
5. Origin of cells and unicellular evolution
 - Origin of basic biological molecule
 - Concept of Oparin and Haldane, Experiment of Miller (1953)
 - First Cell- Evolution of Prokaryotes, Origin of Eukaryotic cell
6. Paleontology and evolutionary history
 - The evolutionary time scale- eras, periods and epochs; major events in evolutionary time scale
 - Origin of unicellular and multi-cellular organisms
 - Stages in primate evolution including Homo.

Unit-III

1. Molecular evolution-
 - Molecular tools in Phylogeny
 - Phylogenetic trees- rooted & un-rooted
 - Molecular clocks
 - Patterns of change in protein (amino acid)
 - Nucleotide sequence analysis sequence
 - Gene evolution
2. Population genetics- Population as a unit of evolution, gene pool, gene frequency
3. Hardy Weinberg Law- Concept and rate of change in gene frequency through mutation, genetic drift, migration and natural selection
4. Adaptive Radiation and divergence; occupation of new environmental and
 - Convergent evolution and co-evolution
5. Isolation and its role in species formation-
 - a) Isolating Mechanism- geographical ecological physiological, Biochemical, anatomical, developmental, behavioral, psychological and social
 - b) Effects of Isolation- restriction of dispersal, restriction on random mating; reduction of fertility.
 - c) Failure of isolating mechanisms- gene flow, migration and heterosis
6. Speciation- Definition of species, Subspecies and races
 - Speciation- Gradual or sudden process
 - Allopathic evolution & sympatric evolution

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
- 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-4 Immunology and Biotechnology

Time: 3 Hour

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. Overview of the immune system:
 - a) Components of the immune system
 - b) Lymphoid Organs- types, lymphocyte production, haematopoietic stem cells
2. Antibody Structure and Diversity
Production, distribution, structure, types
3. Mechanism of Immune Response
Lymphocyte circulation and antigens, antigens –immune responses, role of MHC molecules in antigen recognition and immune responses, transferring viral antigen and APC, lipid- polysaccharide antigen
4. Immune component cells and associated tissues
5. Major Histocompatibility complex
6. Principles of innate and adaptive immunity
7. Humoral and Cell mediated immunity

Unit II

8. The recognition and effector mechanisms of the adaptive immunity- antigen and immunogenicity
9. Antigen recognition B cells and T cells
10. Immunodeficiency Diseases
11. Vaccines and Vaccination

Biotechnology:

1. scope significance, microbes and microbial system and their improvement for biotechnological use.
Principles and techniques of plant and animal cell culture
2. principles and application of DNA recombinant technology
 - a) Recombination and repair
 - b) Holiday junction.
 - c) FLP/FRT and Cre-Lox recombination.
 - d) Rec A and other recombinases.
 - e) DNA repair mechanisms.
3. Molecular mapping of genome
 - a) Genetic and physical maps
 - b) Southern hybridization, fluorescence *in situ* hybridization(FISH) for Genome analysis.
 - c) Molecular markers in genome analysis(RFLP, RAPD and AFLP)
 - d) Basic Idea of Genomics and its application to health and agriculture, including gene therapy.
 - e) Application of RFLP in forensic, disease prognosis, genetic counseling and pedigree analysis.
 - f) DNA Sequencing, Sequencing methods, sequence submission, sequence alignment. DNA fingerprinting

- g) expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequence
- h) construction of genomic DNA libraries in Plasmids, phages, cosmids, BAC and YAC

Unit III

1. Signal transduction in bacteria and animals, Complementation and molecular recognition, liposomes.
2. Molecular biology of Cancer, Oncogenes, Chemical Carcinogenesis, transposons
3. Transgenic animals and knock-outs
 - a) Production
 - b) Applications
 - c) Embryonic stem cells
 - d) Care & breeding of experimental animals
 - e) Bioethics
4. Assisted reproduction technologies
 - a) Embryo sexing and cloning.
 - b) Screening for genetic disorders.
 - c) ICSI, GIFT etc.
 - d) Cloning of animals by nuclear transfer.
5. Fermentation technology, design process, scale up and down stream processing, production of antibiotics, beverages, enzymes, ethanol, and methane from biomass; bioremediation, biopesticides and biosensors, single cell protein

Suggested Reading Materials:

- * 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.
- * Immunology . S S Lal and S Kumar
- * Kuby Immunology, Richard, Thomas, Barbara, Janis, (5th Ed., 2003), W. H. Freeman and company, New York, USA.
- * R A Meyers.(Ed) Molecular biology and Biotechnology. A comprehensive desk reference. VCH

Semester I

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 emphasizing the fauna and their conservation.
 - Visit any National Park, Sanctuary, Forest area or nearby protected area to study biodiversity and live animals of the area. Also, prepare and submit report of the field trip.
- Spotting: Photographs/Models of wild animals of Rajasthan to study their distinguish features, classification, Habit & Habitat and conservation status.

Cell and Molecular Biology

- 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 supravital staining (with Neutral red and Janus green (B) of cells of the testis of an insects or mammal to study mitochondria
 - Preparations and staining of Barr bodies.
 - Chromosome counts in cells of the testis of an insect pest/ bone marrow cells of rodent pest.
 - Observation of cellular organization of testes of Cockroach and Grasshopper by Acetocarmine, Fuelgen staining preparations/ slides/ digital techniques

Biotechnology

- Preparation of multipolar nerve cell from the spinal cord of a mammal.
- Exercise based on DNA fingerprinting, DNA sequencing. .
- Immunoassays RIA, ELISA
- SDS PAGE of soluble proteins and determination of molecular weight.
- Any other exercise based on Biotechnology as per available laboratory instruments.

Genetics

- 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 Mendalim to be done by the students.
- Identification of blood groups in man.
- Demonstration of sex chromatin.
- 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

Evolution

- 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.

Immunology

- To identify different leukocytes by making blood smear.
- To perform Radio Immuno Diffusion (RID)
- To perform Ouchterlony double diffusion (ODD)
- To demonstrate antimicrobial activity of skin

❖ Some exercises based on the syllabi may be devised according to the availability of equipments.

Seminar –

Students must prepare and present Seminar/ paper on the related topics or recent advances/research in the field of life sciences/ topics related to the papers included in the semester; CSIR-NET Life Science Topics must be Emphasized for seminar topics. Student shall prepare and use power point presentations, models, slides etc. for seminar.

Spotting

Spotting may cover all the practical subjects of the semester.

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	18
2. Exercise on Biodiversity/ Wild Life	8
3. Insect Identification using Taxonomic key	6
4. Exercise on Genetics/Evolution	10
5. Exercise on cell and Molecular Biology	10
6. Exercise on Biotechnology/Immunology	10
7. Exercise to study live animals/Report of Field Trip	8
8. Seminar	10
9. Viva	10
10. Record	<u>10</u>
Grand Total	100

M.SC. ZOOLOGY SEMESTER-II

Paper- 6: 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:

- a) Acoelomates, Pseudo coelomates and Coelomates
- b) Protostomia and Deuterostomia

2. Locomotion:

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

3. Nutrition and Digestion:

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

Unit-II

1. Respiration

- a) Organs of respiration : Gills, lungs and trachea.
- b) Respiratory pigments.
- c) Mechanism of respiration.

2. Excretion:

- a) Excretion in lower invertebrates
- b) Excretion in higher invertebrates
- c) Organs of excretion: Coelom, Coelomoducts, Nephridia and Malpighian tubes.

Mechanism of Excretion.
Mechanism of Osmoregulation.

3. Nervous System

- Primitive Nervous systems: Coelentrata 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. I. 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- 7 Biochemistry

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

- Introduction to Structure of atoms, molecules and chemical bonds.
- Introduction to composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids, vitamins and Enzymes).
- Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction).
- Principles of biophysical chemistry (pH, buffer, thermodynamics, colligative properties).

Unit-II

- Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

6. Protein metabolism: metabolic fate of amino group, transamination and deamination, decarboxylation and oxidative degradation of amino acid. Biosynthesis of essential amino acids
7. Stability of proteins and nucleic acids.

Unit-III

8. Carbohydrate metabolism: Glycolysis, kreb's cycle. Pentose phosphate pathway, glyoxylate cycle, glycogenolysis and glycogenesis, gluconeogenesis.
9. Nucleic acid metabolism: Biosynthesis and break down of purine & pyrimidine nucleotide by De novo and salvage pathway. Metabolic regulation
10. Lipid metabolism: Biosynthesis of essential and non-essential fatty acids, formation of ketone bodies, biosynthesis of triacylglycerols, membrane phospholipids. Cholesterol biosynthesis.

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

Paper 8- Physiology and Endocrinology

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 (Animal Physiology)

1. Digestive system:

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

2. Circulatory system:

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

3. Respiratory system

- a) Respiratory organs (gills, trachea and lungs), respiratory pigments
- b) Mechanism of breathing,
- c) Physiology of respiration, control of breathing,
- d) Neural and chemical regulation of respiration

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) Nitrogen excretion and urea cycle
- e) Role of kidney in osmoregulation, urine concentration,
- f) Waste elimination, micturition

- g) Electrolyte balance, acid-base balance.

UNIT-II (Animal Physiology)

5. Muscular system:

- Types and properties of muscles,
- Functional architecture of skeletal muscles,
- Biophysical and biochemical events during muscular activity.
- Neural control of Muscle tone and posture

6. Nervous system:

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

7. Sense organs:

- Structural architecture and functioning of eyes and ears,
- Tactile response.
- Thermoregulation and cold tolerance:
- Heat balance and exchange, endotherms Vs ectotherms,
- Counter-current heat exchanger,
- Torpor, hibernation and aestivation

8. Thermoregulation – Comfort zone, body temperature – physical , chemical, neural regulation, acclimatization

9. Stress and Adaptation

UNIT-III (Endocrinology)

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

- * Hormones- Definitions, types, chemical nature, formation, storage and secretion. Transmission of hormones, Feedback control system found in Endocrine System
- * Pituitary Gland- hormones secreted from different regions of Pituitary gland
- * Thyroid- hormones secreted, physiology anatomy of Thyroid Gland, chemical nature of hormone, synthesis , function, regulation of hormone
- * Parathyroid Gland- hormones, nature and function
- * Thymus- hormones, nature and function
- * Adrenal Gland- hormones, transportation of hormones, degradation and excretion of hormone
- * Pineal body- function of pineal body ; melatonin
- * Pancreas- Hormones, nature and function
- * Gonadal Hormones- hormones, nature and function

11. Reproduction:

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

12. 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 India.
- * 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-9 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 (10 marks): 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.
5. 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 axis in Drosophila, Amphibia, Chick and mammals.
 - 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 organiser)
 - 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. Vulva formation in caenorhabditis elegans.
 - c. Morphogenesis of brain and neural crest cells.
 - d. Differentiation of neurons.
 - e. Development of eye, heart and alimentary canal.
 - f. Genetic regulations on early embryonic development.
 - g. Environmental regulation of development of development.
 - h. Sex determination.

Unit III

Specific aspects of development

1. Embryonic adaptations:
 - a. Evolution of cleidoid egg and its structural and physiological adaptations.
 - b. Development and physiology of extra embryonic 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. Origin, re-differentiation of cells of regeneration.
 - c. Limb development and regeneration in vertebrates.
 - d. Reasons for the absence of limb regeneration in mammals.
 - e. Methods for induction of regeneration.
3. Chick Development upto 96 hrs. of Incubation
4. 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 AS. 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.

Semester-II

Paper- 10 : Practicals

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, Trochopore, Nauplius, Zoea,
- Mysis, Phyllosoma, Trilobite Larvae of limulus, Antedon, Veliger, Bipinnaria, Ophiopluteus, Echinopluteus, Auricularia, tornaria
- Dissection/Virtual dissection using computer software
: Nervous System of Leech, Crab, Scorpion, Mytillus, 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.

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, 21,24, 33, 36,48, 72 and 96 hrs. incubation 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.
 - ❖ 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 as well as from CSIR-NET life Sciences syllabus. 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. Spotting | 18 |
| 2. Dissection | 10 |

3. Permanent Mounting	10	
4. Exercise based on Biochemistry	12	
5. Exercise based on Developmental Biology	10	
6. Exercise based on Physiology/Endocrinology	10	
7. Seminar	10	
8. Viva	10	
9. Record	10	Grand Total

100

M.Sc. ZOOLOGY

Semester- III

Paper-11 Biology of Chordates (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. 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 - Prototheria 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 Autonomy 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 Ecology (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. Introduction to ecology- Introduction to the Environment; Physico-chemical and Biological factors in the Environment; Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere
2. Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of meta population – demes and dispersal, inter demic extinctions, age structured populations.
3. Environmental concepts – laws and limiting factors
4. Ecological models.
5. Acquisition, transformation and utilization of energy - the geochemical, biogeochemical and hydrological cycles; material balance.
6. Species interactions: Types of interactions, interspecific competition, herbivore, carnivore, pollination, symbiosis.
7. Communities: concept; development; structure; Habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement;
8. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones; ecological dominance; regulation of community structure.

Unit-II

1. Ecosystem: Introduction to Ecosystems: concepts; homeostasis; components; flow of energy; productivity, cycling of materials and nutrients, Food chain.
2. Ecosystem dynamics and functioning: role of biodiversity in patterns and processes of communities and ecosystems; stability, disturbance and resilience.
3. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.
4. Ecosystem types and their distribution.: Classification; Major ecosystems of the world and India (forests, grasslands, wetlands, oceans, estuarine, rivers and lakes, deserts). Managed Ecosystems; Agri-Ecosystems, Aquaculture, Urban Ecosystems and Community Forests.
5. Ecosystems and Human well-being: Ecosystem services; Natural and Human induced changes in Ecosystems and their consequences on human well-being.
6. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

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.
8. Bioresource and uses of biodiversity

Suggested Literature:

1. Basic Ecology, Eugene Pleasants Odum. Saunders College Pub., 1983, 613 pages.
2. Fundamentals of Ecology, Eugene Pleasants Odum. Thomson Brooks/Cole, 2005, 598 pages.
3. Applied ecology and environmental management, Edward I. Newman. Oxford Blackwell science, 2000.
4. Ecology and ecosystem conservation, Oswald J. Schmitz. Washington Island Press, 2007.
5. Ecology individuals, populations, and communities, Michael Begon, John L. Harper, Colin R. Townsend. Boston Blackwell Science, 1996.
6. Elements of ecology, Robert Leo Smith and Thomas M. Smith. Benjamin Cummings, 2003.
7. Essentials of ecology, Colin R. Townsend, Michael Begon, John L. Harper. Blackwell, 2003.
8. Metapopulation ecology, Ilkka Hanski. Oxford University Press, 1999.
9. Environment and Sustainable Development, M.H. Fulekar, Bhawana Pathak, R K Kale. Springer India, 2013, 198 pages.
10. Sustainable Development: Environment, Energy and Water Resources, M.K. Ghosh Roy. Ane Books, 2011, 384 pages.
11. Global Environmental Issues, Frances Harris. John Wiley & Sons, 2005, 336 pages.
12. Changing fauna Ecology in the Thar desert, B.K. Tyagi. Q. H. Baqri. Scientific Publishers 2005, 367 pages.
13. Faunal Ecology and Conservation of the Great Indian Desert, C. Sivaperuman, Qaiser H. Baqri, G. Ramaswamy, M Naseema. Springer Science & Business Media, 2008, 222 pages.
14. Thar Desert in Retrospect and Prospect, R.P. Dhir, D.C.K. Joshi and S. Kathju. Scientific publisher, 2018.
15. Thar Desert in Rajasthan: Land, men and Environment, R. P. Dhir, A. K. Singhvi, Amal Kar. Geological survey of India, 1992.
16. An Advanced Textbook On Biodiversity Principles And Practice, Krishnamurty. Oxford and IBH Publishing, 2004, 276 pages.
17. Biogeography: Introduction to Space, Time, and Life, Glen MacDonald. Wiley, 2017, 518 pages.
18. Basic Biogeography, N. V. Pears. Taylor & Francis, 2017, 358 pages.
19. Fundamentals of Eco toxicology: The Science of Pollution, Fourth Edition, Michael C. Newman. CRC Press, 2014, 680 pages.
20. Environmental Law and Policy in India, Shyam Divan, Amin Rosencranz. Oxford University Press India, 2002, 876 pages.
21. Climate Change Policy: A Survey, Stephen H. Schneider, Amin Rosencranz, John O. Niles. Island Press, 2002, 584 pages.
22. Handbook of Environmental Health, Fourth Edition, Two Volume, Herman Koren, Michael S. Bisesi. CRC Press LLC, 2018, 1722 pages.

Semester III

Paper – 15 Practical-I

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, Dolliolum oozoid, Botrylus, Herdmania, and Amphioxus.
- Pisces: Petromyzon, Myxine, Rhinobatus, Pristis, Trygon, Chimaera, Polydon, Acipenser, Amia, Lepidosteus, Protopterus, Lepidosiren, Neoceratodus, Notopterus, Exocoetis, Echeis, Pleuronectes, Mestacembelus, Diodon, Tetradon, Ostracion, Lophis, Syngnathus, Hippocampus, Anguilla, Labeo, Ophicephalus.
- Amphibia: Ichthyophis, Necturus, Proteus, Ambystoma, Axolotl, 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, Gravidalis.
- Aves: Taylor Byrd, Indiana Hoel, Jungle fowl, 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, Ammonoete 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.

Ecology

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

Seminar –

Students must 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 as well as from CSIR-NET life Sciences syllabus. Student shall prepare and use power point presentations, models, slides etc. for seminar.

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.

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

(Duration: Four hours)	Max Marks : 50
a. Internal Organization of vertebrate	5 Marks
b. Permanent Preparation	5 Marks
c. Exercise in Ecology	5 Marks
d. Report of Field Visit/ Project based on Ecology & Environment	5 Marks
e. Identification and comment on spots (five)	15 Marks
f. Seminar	5 Marks
g. Viva-voce	5 Marks
h. Class record	5 Marks
Total 50	
Marks	

Semester - III

Paper- 13 A: Cell and Molecular 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. The cell and its diversity,
 - (a) Diversity of cell and cell theory
 - (b) Diversity of cell-viruses, bacteria, prokaryotes, eukaryotes (Blood Cell, Nerve cell, Gland cell and Muscle cell)
2. Major structural feature of eukaryotic cells: cellular compartments, structural details and function of cell organelles;
3. Cell Wall: Prokaryotic cell wall, Peptidoglycan structure-gram positive and gram-negative bacteria
4. Biomembrane:
 - (a) Variation among membrane,
 - (b) Molecular organization of cell membrane
 - (c) Mobility of lipids and integral proteins in biomembranes
 - (d) Models of plasma membrane
 - (e) Fluid mosaic model
 - (f) Modification of fluid mosaic model.
5. Cell junctions (Gap, tight and desmosomes etc.)

UNIT II

1. Transport across cell membrane
 - (a) Mechanism of diffusion, facilitated diffusion
 - (b) Osmosis and water channels/movement
 - (c) Uniporter-catalyzed transport, GLUT-1 transport and its kinetic
 - (d) Intracellular ion environment and membrane electric potential

- (e) Active transport-P, V and F class ion pumps and ABC superfamily; Plasma membrane and Muscle Ca^{++} ATPase pump and $\text{Na}^{+}/\text{K}^{+}$ ATPase pump
 - (f) Co-transport by symporters and antiporters
 - (g) Transport across epithelia: Receptor mediated endocytosis.
2. Cytoskeleton
 - (a) Microfilaments
 - (b) Actin cytoskeleton:- G-Actin and F-actin and structural and functional polarity
 - (c) Myosin: Structure and mechanism of movement with actin; Conformational changes in myosin during movement.
 - (d) Microtubules: Microtubules structure and microtubule assembly; Microtubule associated proteins (MAP's) and cross linking of microtubules
 - Centrosome duplication
 - Kinetochore and force for poleward chromosome movement.
 - Organization of spindle pole and orientation of assembly.
 - Formation of poles and capture of chromosomes,
 - Astral microtubule and cytokinesis
 3. Cilia and Flagella: Structure and movement

UNIT III

1. Concept of cell surface: Electro-kinetic properties of cell surface, their role in intercellular interactions in cell fusion and cell aggregation etc.
2. Organization of eukaryotic chromosomes at molecular level: structure of Nucleosome, histone and non-histone proteins and higher order compaction of mitotic chromosomes, chromatin structure
3. Specialized chromosomes: Structural organization and functional significance of polytene chromosomes. Structural organization and functional significance of lampbrush chromosome.
4. C-value Paradox, Euchromatin and Heterochromatin. Human karyotype, chromosomal banding (Paris conference nomenclature). Somatic cell genetics : Cell fusion and hybrid agents, mechanism of fusion, Formation of heterokaryon (Hybrid selection and chromosomal segregation). Applications of hybridoma technology.

Semester - III

Special Paper-14 (A): Cell and Molecular 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. Cell cycle and its regulation;. Cell growth and oncogenic transformation.
 - a) Bacterial cell cycle (Helmstetier-Cooper or I+C+D model)
 - b) Partition and cytokinesis.
 - c) Eukaryotic cell cycle-G1, S, G2 and M Phases
 - d) Cell cycle and check points
 - e) Cyclins and cyclin-dependent kinases (CDKs)
 - f) Regulation of CDK cyclin activity.
 - g) Role of proteolysis in cell cycle.
2. Concept of the holliday model of Crossing over, The Meselson-Radding Model of Recombination,
3. Transposable genetic elements of prokaryotes and eukaryotes

UNIT II

1. Cell-Cell Signaling:-
 - a) Endocrine, paracrine and autocrine signaling.
 - b) Receptor proteins-Cell surface receptors and intracellular receptors.

- c) Cell surface receptors-G-Protein coupled receptors, Ion-channel receptors, Tyrosine Kinase-linked receptors and receptors with intrinsic enzymatic activity.
 - d) Second messenger System-cAMP and IP3 & DAG
 - e) MAP Kinase cascade, JAK/STAT and TGF-B, Smad signaling
 - f) Signaling from plasma membrane to nucleus (a) CREB links cAMP signals to transcription (b) MAP kinase.
 - g) Signal transduction in disease and immunity.
2. Signal-Mediated transport through nuclear pore, Nuclear pore complex : Nuclear Export Signals and transport of proteins from nucleus to cytosol; Nuclear Localization signal and transport of cargo proteins from cytoplasm to nucleus.

UNIT III

1. Regulation of Gene Expression
 - (a) Operon Concept
 - (b) Positive and Negative regulation of gene expression
 - (c) Inducers and co-repressors
 - (d) Regulation by attenuation: his and trp operons
 - (e) Eukaryotic transcriptional control.
2. DNA binding proteins and gene regulation
 - (a) DNA binding domains
 - (b) Homeodomain proteins
 - (c) Zinc finger proteins
 - (d) Winged-helix (Forked head) Proteins
 - (e) Leucine-Zipper proteins
 - (f) Helix Loop helix proteins

Semester III

Paper 16 Practical-II

Practical work based on Special Paper Cell and Molecular Biology13A & 14 A

1. **Handling and operation of following apparatus and instruments:**
 - a. Phase contrast microscope, Microtome
 - b. Electrophoretic, chromatographic and electrophysiological equipments
2. Study of stained preparations of mitochondria and golgi bodies under the light microscope
3. Study of germ cells; smear preparation of spermatozoa from vas deferens (vital staining) and permanent preparation of a single ovum
4. Biochemical estimations of the following in various tissues:
 - a. Lipids: lecithin, cephalin & cholesterol
 - b. Carbohydrates: Glycogen
 - c. Proteins
 - d. Amino Acids: chromatographic and Electrophoretic separation
 - e. Ascorbic Acid
5. Study of unfixed materials
 - a. 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 subjected 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.

Semester III

Marks Distribution Special Paper (A) : Cell and Molecular biology

(Duration: Four hours)

Scheme of Practical Examination & Distribution of Marks.

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

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

Atmosphere and Global environment

1. Impact of environment at cellular level: Cellular interaction with environment.
 - a) Basic Metabolic rate and body size
 - b) Concept of Homeostasis. Metabolism and climatic adaptations:
 - c) Hibernation and aestivation. Poikilotherms and Homeotherms. Asphyxic responses.
2. Response to temperature and pressure. Haematological changes. Thermal properties of water and survival limits. Acclimatization.
3. Greenhouse 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

Natural Ecosystem

1. Concept and components of ecosystem.
2. Ecosystem types and there distribution (forests, deserts grasslands, Wet lands, oceans, rivers and lakes, deserts)
3. Managed ecosystem (Agri-ecosystem, aqua culture, urban ecosystem & community forests.)

Unit-III

Sustainable Development

1. Concept of sustainability, parameters of sustainable development Issues & Challenges.
2. Mechanism to ensure sustainability of ecosystems -
 - Changes in Institutional & Environmental Governance Ecosystems.
 - A vision for sustainable future framework: Economic and financial intervention
 - Social and behavioural Changes, Technological options

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 overgrazing
 - 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. Major Classes of pollutants (Inorganic, Heavy metals, organics, organometallic, radioactive, gases.
2. Major routes of entry of pollutants in ecosystem (Land, water, atmosphere)
3. Fate of pollutants in ecosystem: Bio-magnification, bioaccumulation.
4. 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. Role of GIS & Remote sensing in surveillance, monitoring, risk assessment estimation of loss & planning.
5. Environment, Health and community
 - 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.

Semester III Paper 16 Practical-II

**Practical Work based on Special Paper13 & 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.

Semester- III

Scheme of Practical Examination & 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		

Semester III

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 up to orders and suborder.

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

- a. *Protura*
- b. *Collembola*
- c. *Thysanura*
- d. *Diplura*
- e. *Isoptera*.
- f. Psocoptera
- g. Thysanoptera
- h. Anopleura

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*
- f. *Odonata*
- g. *Orthoptera*
- h. *Dermaptera*

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 Endocrine system
- f. The Reproductive system.

Special Paper-14(C)- Entomology

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. The insect Internally

- Sense organs
- Sound
- light producing organs
- Muscular system
- Nervous system.

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-III

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 16 Practical-II

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. 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-

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- 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/slid 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	
Total		50 marks	

Semester III

Special Paper 13(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. 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

Semester - III

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

Semester III

Paper 16 Practical-II

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.

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Semester III

Marks Distribution For Special Paper (D): Fish Biology

(Duration: Four hours)

Scheme of Practical Examination & Distribution of Marks.

1. Major dissection		10 Marks
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
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Total		50 Marks

Semester III

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.

Semester -III**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 16 Practical-II

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.

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(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.

Semester-III

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
Total 50 Marks	

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 Nobel, G. The Biology of the Amphibia. Dover Publications, New York.
- Gilbert, S.F. Developmental Biology, Sinauer Associates Inc., Massachusetts. 4th 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

Semester-III

Paper-13 (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. Pituitary; General, developmental and comparative anatomy,
3. Functional cytology of the pituitary gland and mammalian, and sub-mammalian vertebrates, adenohypophyseal hormones their chemistry and physiology.
4. Chromatophore 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.

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 pancreatectomy
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

Semester-III

Paper-14 (F) Endocrinology (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. 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.

- 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 16 Practical-II

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

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

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.
- 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 & 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 50 Marks

Semester -IV

Paper – 17 Biological Techniques and Biostatistics (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

- Histochemical and Immunotechniques:Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, Basics of Microscopy, Phase Contrast microscopy, Electron Microscopy, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH, Principle and working of microtomy and types of Microtomes.

2. Biophysical Method: Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
3. Principle of Chromatography, Different types of Chromatography: TLC, Paper Chromatography, HPLC, Gas Chromatography, Ion-Exchange Chromatography. Principle of Centrifugation, types and care of Rotors, working and uses of different types of centrifuge including analytical centrifuge. Principle of Electrophoresis, Agarose Gel Electrophoresis, PAGE, Isotachopheresis .

Unit-II

4. Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
5. Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy.
6. Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT .

Unit-III

7. Statistical Methods:
Elementary idea of Computer Fundamentals (MS Word, Excel and Power Point Presentation); Frequency Distribution; Graphical Presentation of Data (line diagram, Histogram, Bar diagram and Pie diagram); Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X^2 test;; Basic introduction to Multivariate statistics.

Suggested Reading Materials:

- Locquin and Langeron. Handbook of Microscopy. Butterworths, 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-ElBS Edn.
- Allan Bluman Elementary Statistics: A Brief Version (5th Edition

Paper-18 Animal Behaviour (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. Introduction:

Ethology as a branch of biology, Difference between Psychology and Ethology.

Contribution of Scientists for Animal Behaviour, Contribution of Konrad Lorenz, Niko Tinbergen and Karl Von Frisch.

2. Concepts and Patterns of Animal Behaviour: Introduction of concepts and Patterns, Motivation, Fixed Action Pattern, Sign Stimulus, Innate Releasing Mechanism, Action Specific Energy, Behavioural Genetics.

3. Approaches and methods in study of behavior; Proximate and ultimate causation.

4. Neural Basis of Learning: Brain and Behaviour-Role of different parts of brain in Behaviour, Memory, Neural Mechanism of Learning.

Unit-II

1. Biological Clocks- Circadian and Circannual rhythms; Orientation- Kinesis and Taxis
2. Social Behaviour: Advantages of being Social, Non-human Primate Social Groups with emphasis on Social dominance, Sociobiology.
3. Use of space and territoriality, Aggressive behavior, Animal Communication-Auditory, Visual, Chemical and Tactile.
4. Habitat selection and optimality in foraging with emphasis on feeding strategy in Animals.

Unit-III

1. Courtship and mating Behaviour in Animals, Reproductive success in Animals.
2. Parental Care Behaviour, Human Behaviour
3. Learning: Habituation, Classical conditioning, Operant learning, Latent Learning, Imprinting, Reasoning and insight learning.
4. Bird Migration and navigation, Fish Migration, Domestication and behavioral changes, Zoochosis

Suggested Reading Materials:

1. Eibl-Eibesfeldt, I. Ethology. The biology of Behaviour. Holt, Rineheart & Winston, New York.
2. Gould, J.L. The mechanism and Evolution of Behaviour.
3. Kerbs, J.R. and N.B. Davies : Behavioural Ecology. Blackwell, Oxford, U.K.
4. Hinde, R.A. Animal Behaviour : A Synthesis of Ethology and Comparative Psychology. McGraw Hill, New York.
5. Alcock, J. Animal Behaviour : An Evolutionary approach. Sinauer Assoc. Sunderland, Massachusetts, USA.
6. Bradbury, J.W. and S.L. Vehrencamp. Principles of Animal Communication. Sinauer Assoc. Sunderland, Massachusetts, USA.
7. Manning and Dawkins: An Introduction to Animal Behaviour

Semester IV

Paper 21 Practical-I

Practical Work based on General Papers

Animal Behaviour

- (i) Study of the process of learning in rat with the help of Animal Maize. Analysis of the results of the experiment
- (ii) Study of avoidance behavior in rat, analysis of the result of experiment.
- (iii) Imprinting in precocial birds
- (iv) Chemical communication in Earthworm
- (v) Study of food preferences and feeding behaviour of an insect pest
- (vi) Study of phototactic response in Tribolium/ Musca/ Drosophila
- (vii) Learning by trial and error in animals using maze and jumping box
- (viii) Study of movement of fish in aquarium
- (ix) Study of courtship in birds
- (x) Food preference in tribolium
- (xi) Pheromones in earthworms
- (xii) Study of imprinting in chicks

Biological Techniques

- Demonstration of different types of Microscopes
- Demonstration of different types of Spectrophotometers and exercise based on Spectrophotometer.
- Demonstration of Chromatographic equipment and exercise based on Chromatography.
- Demonstration of Electrophoresis equipment and exercise based on Electrophoresis.
- Exercise based on DNA fingerprinting, DNA sequencing.
- Demonstration of Microtome and exercise based on microtomy.
- Visit to tissue culture lab

Biostatistics –

- Exercise based on computer (MS Word, Excel, PPT).

- Preparation of frequency tables, histograms, Bar Diagrams, 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 in the semester as well as based on Life Sciences syllabus of CSIR-NET . 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.

Scheme of Practical Examination & Distribution of Marks

(Duration: Four hours)

Max Marks: 50

1. Exercise in Animal Behaviour	10 Marks	
2. Exercise in Biological Techniques	10 Marks	
3. Exercise in Biostatistics	10 Marks	
4. Seminar	10 Marks	
5. Viva-voce		5 Marks
6. Class record		5 Marks
Total		50 Marks

Semester IV

Special Paper 19(A): Cell and Molecular 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. Complete knowledge of the origin and characters of following diseases:
 - (a) Glycogen Storage Disease
 - (b) AIDS
 - (c) Thalassemia
 - (d) Muscular Dystrophy
 - (e) Cystic Fibrosis
 - (f) Severe Combined Immuno- Deficiency syndrome (SCID)
 - (g) ATM disease
2. Cytokines related diseases:- Bacterial septic shock; Bacterial toxic shock; Lymphoid and myeloid cancers; Chagas disease

Unit II

1. Immune system in health and disease
 - (a) Immune response to infectious disease
 - Viral infections- Viral neutralization by humoral response; Cell-mediated antiviral mechanism; Viral evasion of host defense mechanisms.
 - Bacterial infections- Immune responses to extracellular and intracellular bacteria; Bacterial evasion of host defense mechanisms
 - Protozoa and diseases
 - Diseases caused by helminthes
2. Cancer:
 - a) Tumor cells and onset of cancer
 - b) Tumor Viruses, Proto-oncogenes and tumor suppressor genes
 - c) Mutation causing loss of cell cycle.
 - d) Mutations affecting genuine stability
 - e) Relationship of the cell cycle to Cancer, P53 & oncogenes; oncogenes & ageing.
 - f) DNA repair and cancer.
3. Cell Death
 - a) Apoptosis and necrosis
 - b) Characteristics of apoptosis
 - c) Genes involved in apoptosis

Unit III

1. Ageing: The biology of senescence
 - a) Maximum life span and life expectancy
 - b) Causes of ageing:- Genetic instability; Free radicals, oxidative damage and antioxidants; Role of telomerases in Ageing.
2. (i) Hypersensitivity: Type I, II, III and IV
(ii) Autoimmunity
 - (a) Organ specific autoimmune disease
 - (b) Systemic autoimmune disease
3. Genomics & proteomics: Definition & basic concepts. DNA microarray; ESTs. Multigene families & genome conservation. Proteomics

Semester IV

Special Paper 20 (A): Cell and Molecular 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. Specialized function of cytoplasmic components in a cell with special references to the molecular mechanism (Contractibility, secretion, phagocytosis and pinocytosis).
2. Cell and Tissue Culture
 - (a) Behavior of cells in culture
 - (b) Primary and established cell lines
 - (c) Kinetics of cell growth
 - (d) Culture media
 - (e) Importance of cell and tissue culture
3. Chemical basis of fixation and staining .

- (a) Fixation and Fixatives: Methods of fixation, chemicals used as fixatives and their preparation, chemical basis of fixation (formaldehyde, glutaraldehyde, chromium salts, mercury salts, alcohol and acetone), washing and post fixation methods, decalcification, Cryopreservation.
- (b) Microtomy- Dehydration, clearing and infiltration, embedding methods, trimming, sectioning. Cryostat sectioning and mounting, mounting media, freezing techniques, freeze drying, freeze fracture and itching.
- (c) Staining techniques (Nuclear and Cytoplasmic Stains):- PAS, Metachromasia, Lipid and protein staining techniques.; Intra-vital and supravital staining

UNIT II

1. Elementary concept of the principle and applications of microscopy as exemplified by the following:-
 - (a) Light Microscopy
 - (b) Phase contrast microscopy
 - (c) Florescence microscopy
 - (d) Confocal microscopy
 - (e) Atomic force microscopes
 - (f) Electron microsocopy
 - (g) Micrometry.
2. Principles and application of pH meter, colorimeter, spectrophotometer, centrifuge and ultracentrifuge, electrophoresis (Paper, agarose, PAGE), chromatography (TLC, ion exchange, column, HPLC).

UNIT III

1. Blotting techniques-Southern, Northern and Western blotting.
2. Immunoassays:- Principles, methods and applications of RIA and ELISA.
3. Role and mechanism of action of the following enzymes:-
 - (a) ATPase
 - (b) Succinic Dehydrogenases
 - (c) Acid and Alkaline phosphatases
 - (d) Hyaluronidase

Semester IV

Paper 22 practical-II

Practical work based on Special paper Cell and Molecular Biology

1. Microtomy- Wax, fresh, frozen and fixed frozen sections, sectioning of gelatin embedded material
2. Histo-chemical demonstration
 - a. Acid haematin of Baker & its modification
 - b. Grkamoto's method
3. Cytochemical demonstration
 - a. Millon's reaction
 - b. Ninhydrin Schiff method
4. Histo-cytochemical method:
 - a. Methyl Green Pyronin method
 - b. Feulgen staining
 - c. Periodic acid Schiff method
 - d. Alcian blue method
 - e. Bromo phenol blue method
5. 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 (19 A and 20A Based) Cell and Molecular 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
Total 50 Marks		

Semester -IV

Paper-19 (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

1. Weather and climate
 - a) Atmosphere- structure and composition
 - b) 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 issues related to water, air and soil pollution, food borne, vector-transmitted diseases, effect of radioactive pollutants.
2. Environmental Hazards - Concept of hazard, disaster, vulnerability, exposure and response.
3. Natural hazards- Earth quake, volcano, mass-movement, Tsunami flood, drought , cyclone, extreme weather events.
4. Manmade hazards:- epidemic wildfires, lesions from Bhopal & Chernobyl Disaster
5. Movement, distribution and fate of toxins:
 - a) Bioaccumulation
 - b) Bio magnification
 - c) Translocation of xenobiotic: absorption, biotransformation, excretion
6. Measuring toxicity (acute, sub-chronic and chronic), Bioassay (dose response curve, LC-50, LD-50.)

Paper-20 (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-
 - (i) Major terrestrial biomes
 - (ii) Bio geographical 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, Eco zones, National parks, Sanctuaries, Reserves

- e) Management, special protection programs (Tiger, Rhino, Lion tailed macaque, Elephant)
- 5. Legal aspects of Environmental Protection & Conservation
 - a) National Legislation - Article 48 A and 51 A (g) of Constitution of India, Forest (Protection) Act, (1927), Environment (Protection), Act (1986), Biodiversity Act (2000) Bio safety Framework.
 - b) IPR,UPOV,ITPGR

Semester IV
Paper 22 Practical-II

Practical Work based on Special Paper (19 B and 20B)
Environmental Biology

1. Microscopic examination of water to study Indicators of pollution, planktons, benthic and littoral fauna and flora
2. Soil/Sediment analysis
 - a. EC
 - b. pH
 - c. Alkalinity
 - d. Organic matter
 - e. Texture
 - f. Salinity
3. Air quality monitoring
 - a. Setttable matter
 - b. Suspended particulate matter
4. Write characteristics of different biomes and mark their location on India's map.
5. Determination of the concentration of following insecticides in water:
 - a) DDT
 - b) Methyl Parathion
6. 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 (19 B and 20 B based): 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

Semester -IV

Paper-19(C) Entomology (Special Paper)

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper will be divided into three 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 pest of crop:
Wheat, paddy, maize, jowar, millet, sugarcane, cotton and oil seeds.
- 2 A study of pest of stored grains.
- 3 Ways and means of storage of food grains.

Unit II

- 1 A general idea of plant protection organisation in India.
 1. Fruit , vegetables and timber plant (Mango, Guava, Pea, Ladyfinger, Bringel, Cabbage) pest and tools as sprayer to use the pesticide on these.
 2. Beneficial insect: Silk worm, honey bee, Wasp, and lac insect and their industries.

Unit III

- 1 Important insects used in biological control.
- 2 Ecology: Effect of physical factors, (with special reference to Rajasthan) intra specific and interspecific relations, dynamics of populations.
 1. Embryonic and postembryonic development; Diapause.

Paper-20 (C) Entomology (Special Paper)

Time: 3 Hours

Max. Marks: 50

Note:

Syllabus of each paper is divided into three units. The question paper 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 behaviour, 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, endoparasite 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 Fenimore, 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 (John R. Meyer)

Paper-22 Practical -II

PRACTICAL BASED ON PAPER 19 &20 (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. Familiarity with techniques and appliances of applying insecticides, experiments for testing the insecticides.
6. Knowledge of rearing insects and of maintaining the insectary.
7. Microtechnical procedures.
8. A tour to visit important centre of entomological studies(Compulsory).

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.

Distribution of Marks for Entomology Special Paper

Duration 4 hours

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

Total 50 Marks

Semester IV

Special paper 19 (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)

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

Semester - IV

Special paper 20 (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)

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

Semester IV

Paper 22 Practical-II

Practical work based on Special Paper 19 & 20 (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.

Semester IV

Marks Distribution For Special Paper (D): Fish Biology

(Duration: Four hours)

Scheme of Practical Examination & 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

Semester -IV

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. 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.

Semester -IV

Paper-20 (E) Molecular Developmental 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

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 (pleiotropism; phenocopies; enolization)
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.
- Kingsely Nobel, G. The Biology of the Amphibia. Dover Publications, New York.
- Gilbert, S.F. Developmental Biology, Sinauer Associates Inc., Massachusetts. 4th 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

Semester IV

Paper 22 Practical-II

PRACTICAL WORK BASED ONSPECIAL PAPER 19 &20 E 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. Isolation and analysis of total RNA from Chick embryo cDNA synthesis and PCR analysis.
12. Demonstration of endonuclease activity of DNA fragment.
13. Biochemical changes during development – protein, nucleic acids–semi auto analyser study.
14. Chick embryo whole mount *in-situ* hybridization.

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- 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	

Semester -IV

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

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: chromatophore 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 secretion, effects of thyroidectomy; calcitonin, its chemistry and physiology

Unit-II

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

Section - C

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

Semester -IV

Paper-20 (F) Endocrinology (Special Paper)

Time: 3 Hours

Max. Marks: 50

Note:

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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. Hormonal control or sex differentiation nuclear sex.
2. The female reproductive system: Comparative anatomy and physiology of the mammalian and sub-mammalian ovary and sex accessory structures, ovarian hormones and their functions.
3. 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

1. The gonadal hypophyseal-hypothalamus relationship.
2. Breeding seasons in vertebrates, evolution of viviparity, induced spawning in fish and frog.
3. Endocrinology of fertilization implantation. delayed implantation. parturition and lactation.
4. Placenta as an endocrine tissue foeto-placental unit.
5. 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.

Semester IV

Paper 22 Practical-II

PRACTICAL WORK BASED ON PAPERS 19 & 20 (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 :

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- 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-IV

Marks Distribution for special Paper 19 & 20 (Endocrinology)

Duration—Four hours

Max-50 marks

- | | |
|--|----------|
| 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 : 50 marks

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